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NEW YORK, JUNE, 1890.

AN International Exhibition of Mining and Metallurgy is to be held in London, beginning in July next and continuing until September. The Board of Managers includes a long list of distinguished persons. The subjects within the scope of the Exhibition include mining machinery of all kinds, especially appliances for the mining of different metals, such as gold, silver, copper, tin, lead, iron, etc.; coal mining; petroleum; assaying and testing; electricity in its application to mining; explosives and their use; mining and metallurgical literature, and in general everything relating to the mining of ores and the extraction of metal from them. Exhibits are invited from all countries.

THE present seems to be the age of international exhibitions, and the latest one noticed is to be held in the Island of Jamaica under the auspices of the Government of that colony. In this case a special desire is expressed to secure the co-operation of American manufacturers, and a large space will be reserved for exhibits from this country. The Exhibition is represented in the United States by Mr. Thomas Amor as Secretary, and he may be addressed at No. 280 Broadway, New York City. This seems to be a favorable opportunity to promote trade between this country and the West Indies, as there will probably be a large attendance from all the islands.

ACCORDING to accounts given in German technical papers, the locomotive builders of that country have formed an agreement to prevent underbidding for contracts and to keep up the price of locomotives, which, it is claimed, had fallen to an excessively low point in consequence of too great competition. The agreement is to continue for five years, but its terms, or the manner in which it is to be enforced, are not stated.

In this connection it may be of interest to note the present prices of locomotives in Germany. In the bids recently received for a large order for the Prussian State Railroads, the prices named were, for express passenger locomotives, $12,114; for ordinary passenger locomotives with tenders, $11,626; for freight locomotives, $10,710. These bids, it may be noted, were put in after the new agreement had been made, and represented an increase of from 16 to 30 per cent. over previous prices.

THE manufacturing industries of the Pacific Coast have been restricted in their development to a considerable extent by the high cost of fuel, which has been sufficient to offset the cost of transportation, and thus enable the Eastern or foreign manufacturer to compete with the local factories. In California there is very little coal, and that not of good quality. The new State of Washington, however, has coal measures of large extent, and the coal is of excellent quality. Its development has already begun, and is proceeding as fast as transportation facilities are provided, so that there is little doubt that in a few years its mines will be able to supply the demand of all the Pacific States, and the ports on Puget Sound will be the shipping centers of a great coal traffic.

This abundant supply of fuel, with its other mineral products and its extensive tracts of fine timber, seems to show that in the future Washington will be the great manufacturing State of the Pacific slope, and will in time hold a position corresponding to that of Pennsylvania in the East.

Two bills have been introduced in Congress at the present session to provide for the use of safety appliances on railroad freight trains. The first, which was prepared by Senator Allison of Iowa, provides that all companies engaged in interstate commerce shall provide all new cars, and all cars brought into shop for repairs, with automatic couplers, and that after January 1, 1895, the use of cars not provided with such couplers shall be prohibited. It is also provided that all locomotives shall be equipped with driver brakes, and that after January 1, 1893, it shall be unlawful to run any train which has not a sufficient number of cars in it equipped with power or automatic brakes to give the control of the train to the engineer. A penalty of not less than $500 nor more than $1,000 is provided for infractions of the law. The Interstate Commerce Commission is charged with the duty of requiring reports from all companies under its jurisdiction as to the number of cars and engines used and the number equipped with automatic couplers and with brakes. A final provision authorizes companies to refuse to receive cars not properly equipped.

The second bill, which has been introduced by Senator Collom of Illinois, provides for the appointment of a Board of five members, at least two of whom must be practical railroad men and two versed in car construction. This Board is to investigate the car couplers in use and any designs that may be presented, and to make such tests as may be necessary to decide what type of coupler is best, and to report its conclusion to the Interstate Commerce Commission. The Board is given one year in which to make such a report, and after its decision is presented and filed, the railroad companies are required to adopt such couplers as may be decided upon, and to introduce and equip their cars with the same under heavy penalties, a reasonable time being given to accomplish the work.

There does not seem to be much prospect that either of these bills will pass at the present session, as the time of Congress is pretty fully taken up with other matters. In the mean time, the whole subject of Federal regulation of

safety appliances was to be considered at the Conference in Washington, May 28, at which it was expected that the Interstate Commission and all the State Commissions would be fully represented.

THE total mileage of track laid on new railroads in the United States up to May 1 of this year is reported by the *Railway Age* at 1,084 miles. The early part of the year was unusually favorable for tracklaying, owing to the absence of severe cold and snow over a great part of the country, and this may possibly have had some effect upon the extent of the new mileage. It is nevertheless true that the first part of the year is that in which the least tracklaying is done, and an addition of 1,100 miles during one-third of the year may be taken to indicate that the railroad building of 1890 will be at least equal to that of last year, when 5,200 miles were built, and may possibly exceed it.

As was the case last year, a large proportion of the new track was in the Southern States, Georgia leading with 170 miles and North Carolina coming second with 135 miles; no other State reports over 100 miles. In New England and the Middle States the mileage was small and no large increase is reported in the West or Northwest, while on the Pacific Coast railroad building seems to have come to a stand-still for the present.

THE city of Newark, N. J., has erected in its chief public park a statue of Seth Boyden, an inventor who did much to start the old New Jersey town on its prosperous career as a manufacturing city. Mr. Boyden was engaged in various occupations; he invented the process of making patent leather, that of making malleable iron castings, and many improvements in steam-engines, in building which he was engaged for many years. He was also one of the early locomotive builders, having constructed in his shops in Newark in 1837 two engines for the Morris & Essex Railroad, which successfully worked the grade of 140 ft. to the mile between Newark and East Orange—a feat unprecedented in those days. It is claimed that on these engines he used for the first time outside connections and a sort of link motion, the drawings of which have, unfortunately, been lost. He did not continue long in the locomotive business, the two engines named and one which was sent to Cuba being all that were built in his shop.

Business complications left Seth Boyden a poor man in his old age, but he was undoubtedly a mechanic of great ability, and the city where he spent nearly all his active life has done well in honoring his memory.

THE project for the American International Railroad has been brought formally before Congress by a brief message from the President transmitting a note from the Secretary of State upon the agreement reached in the late so-called Pan-American Conference. In this message Congress is asked to appropriate the sum of $65,000, which would be the estimated share of the United States in the cost of the preliminary surveys required.

The proposed line is intended to connect the United States with the different South American countries, and for that purpose it is proposed to make use of the railroads already built in Mexico, Peru, Chili and the Argentine Republic, the new line to fill in the gaps now existing between those different countries. In the recent Conference an agreement was reached for the making of a survey to ascertain the best and most economical routes under the direction of an International Commission, the expense to be shared by the several nations concerned in proportion to population. The headquarters of the Commission are to be located in Washington, and its first meeting will probably be held in October next. The United States will be represented in the Commission by three members, and it is probable that the actual work will be placed in charge of a small sub-committee.

LATER advices concerning the breakdown of the engines of the *City of Paris*, while they contain much information as to the condition of the engines and of the ship, do not yet make altogether clear the cause of the accident. The low-pressure cylinder, which gave way, was completely broken up, and judging from the engravings published in our contemporaries, *Engineering* and the *Engineer*, the engine-room presented the most extraordinary scene of destruction ever found on an ocean steamer. The after, or low-pressure cylinder, was a complete wreck, and almost every part of the engine was out of place, although the intermediate and high-pressure cylinders were not badly broken. Contrary to the first advices, the bottom of the ship was not injured, the water which came in having entered entirely through the valves, which could not be closed, as it was impossible for the engineers to reach them.

As to the cause of the accident, there is still some difference of opinion; but the weight of evidence seems to show that it resulted from the breaking of the propeller shaft, and that that break occurred in consequence of the wearing down of the outboard bearings of the shaft. The brass sleeve, it was found when the ship was docked, had entirely disappeared with the exception of two rings, probably the collars at the end. The propeller shaft itself was practically undamaged, but the metal studs which attached the sleeve were worn down level with the shaft. The result of this wear would be the dropping of the after end of the shaft, throwing an enormous strain upon the level portion, and under this strain there was a fracture close to the next point of support, which was in the stern close to where the shaft emerged from the ship. The breaking of the shaft would, of course, permit the engines to race at a high speed, and the immediate result was the breakage of the low-pressure cylinder, probably in consequence of the piston striking the head. It may be added that careful examination showed no defective metal in any part of the shaft or engines.

One peculiarity of this accident is that when the engine gave way sufficient damage was done to the engine driving the other screw to stop that also. Among the advantages urged in favor of the twin-screw system has been the improbability of both engines giving way at once, and it is somewhat strange that in the first serious accident occurring to a large steamer built with twin-screws both engines should be stopped. As has been already stated, it is evident that the danger to the ship resulted chiefly from the manner in which the outboard valves were worked and the impossibility of closing them anywhere except from the engine-room. If any special lesson is taught by the accident beyond this, it is the necessity of strengthening the outer bearings of the propeller shaft.

THE Committee which has in charge the arrangements for the American meeting of the Iron and Steel Institute of Great Britain held a meeting in New York recently, and has about completed the arrangements. It is understood that the members of the Institute will arrive in New

York about October 1, and will be present at the meeting of the American Institute of Mining Engineers, which is to be held in New York at that date. It is stated that about 450 members have signified their intention to join in the meeting, and that they will be accompanied by some 50 ladies. After the meeting two excursions have been arranged: One through the coal and iron regions of Pennsylvania to Pittsburgh, thence to Chicago and the copper mines of Lake Superior, returning by Detroit and Niagara Falls. The other excursion will go to Birmingham, Ala., by way of Cincinnati and Chattanooga, returning through East Tennessee and Virginia. The International Conference, in which the British and American associations will join, will be held in Pittsburgh. It is also expected that a number of members of the German Union of Iron Manufacturers will be present, with metallurgists from other European countries.

THE last great bridge proposed is one to cross the Mississippi at New Orleans, and plans have been prepared for this bridge by Mr. T. C. Clarke, the well-known engineer. His design is for a main bridge of three spans, the central one to be 1,200 ft. with a clear height of 180 ft. above the water, while the shore spans would be 800 ft. each. On account of the low level of the banks on either side of the river a very sharp grade will be necessary to rise to the height required to avoid interference with navigation, and it is proposed to operate the railroad line over the bridge on the Abt rack-rail system. The great difficulty at New Orleans probably will be in finding proper foundations for the piers, and long spans would be advisable not only on account of navigation, but also of the expense of foundations. A draw-bridge is not admissible at New Orleans, and indeed there is great opposition from the local and river interests to a bridge of any kind at that point.

THE naval bill for this year is still hanging between the House and the Senate, and it is uncertain how large an appropriation will be made for new vessels, and what policy will be adopted in building them. As has been before noted, considerable opposition was manifested in the House to the policy of building battle-ships which was outlined in Secretary Tracy's report, and there seems to be no prospect at present of any progress toward the adoption of the extensive programme outlined by the Naval Policy Board. The preference of the House, as shown in the discussions, was evidently for more cruisers if any new vessels were to be built, while the Senate is more inclined toward the Secretary's plans.

No progress has been made with the bill which provides for subsidizing merchant vessels, which can be used on occasion as a naval reserve, which can be armed and put into service as cruisers. Such a measure seems to have many advantages, and if an appropriate bill of this kind could be passed, good results might doubtless be expected. The Secretary has recommended a special appropriation to provide the necessary arms and equipment for the battalions of the Naval Reserve which have been formed in New York and elsewhere, and this also seems to be a desirable measure, especially as the expense would not be great. Meantime work continues on the naval vessels already decided upon and in progress, and the additions to the active fleet during this and next year will be very considerable.

The gun appropriations are also still undecided, but there seems to be little doubt that considerable amounts will be made available for the construction of new guns both for the Navy and for the Army.

As noted elsewhere, the present month will probably conclude the official trial trips of the cruiser *Philadelphia* and the torpedo boat *Cushing*. From preliminary trials the *Philadelphia* is expected to make an excellent showing, and to prove herself at least as fast a vessel as the *Baltimore*. The *Newark* and the *San Francisco* will probably also be ready for their trial trips before long. During the present month also bids will be received for the new armored ship, and the contract for her construction will probably be let.

IT appears from the records of the Bureau of Navigation that there were built in the United States in 1889 a total of 1,077 vessels registering 231,134 tons. Of these 769 were built on the seaboard and were generally of small size, their total tonnage being 111,852, or an average of 145½ tons each. The number built on the Mississippi and its tributaries was 83, and their total tonnage 12,202, an average of 147 tons each.

The most important shipbuilding of the year was on the Lakes, where 225 new vessels are reported, of total tonnage of 107,080 tons—which is very nearly equal to the seaboard tonnage. The number of vessels was much less, but their size greater, the average being 476 tons each. The lake building was thus the more important from its size, including a number of large carriers.

It may be noted that the total tonnage reported for last year shows a large increase over 1888 and 1887, and is more than three times as great as the total for 1886.

THE pig iron production of Great Britain last year showed an increase of about 4½ per cent. over the previous year, the gain being in forge and foundry irons entirely. The steel production showed an increase of about 6½ per cent., although there was a falling off of a little over 3 per cent. in the output of steel rails.

The following table shows the production of pig iron and Bessemer steel in the United States and Great Britain respectively, in 1889:

	United States.	Great Britain.
Pig iron, tons	8,516,079	8,245,336
Bessemer steel rails	1,691,264	943,048
Bessemer steel, other than rails	1,584,364	1,665,122

The increase in the United States over 1888 was much greater than in Great Britain, the gain being 17½ per cent. in pig iron, 9 per cent. in steel rails, and 31½ per cent. in steel in other forms.

THE last report of the Hungarian State Railroads shows that on those lines in the year covered—1888-1889—no passenger was killed by accident. There were, however, 59 employés killed and 158 injured, while of other persons 76 were killed and 38 injured. Of this last-named class most apparently of the casualties resulted, as in this country, from unprotected crossings and from persons walking on the track. There was a slight increase in their number over the previous year, which is said to have resulted from the increased traffic. The greatest interruptions to traffic recorded were not from accident, but from snow blockades and floods.

The report notes that a decrease in the number of slight accidents and an increase in the general convenience and accommodation of travellers have resulted from several

measures which have been adopted by the administration. The first of these is the increased use of continuous or train brakes, both the Westinghouse automatic and the Hardy vacuum brake being in use. In one case experiments have also been made with the Carpenter air-brake, but its use does not seem to have been extended.

In the heating of carriages, experiments have been made with steam heating, using steam from the locomotive, and have resulted so favorably that this system will probably be adopted for all passenger trains. During the present season already 1,040 cars have been provided with the necessary equipment.

A minor improvement has been the introduction of spark-arresters of American pattern, which have been applied to several lines where a very soft coal is in use with greatly increased comfort to passengers and without the unfavorable results as to combustion which some of the German mechanics had predicted.

THE MECHANICAL ENGINEERS' CONVENTION.

THE meeting of the American Society of Mechanical Engineers in Cincinnati was in many respects a successful one ; in point of attendance it was fully up to the average, and some work was accomplished. Nevertheless a certain amount of criticism seems to be in order.

The papers, it must be said, were none of them of remarkable interest or weight, and the discussions were chiefly carried on by the younger and inexperienced members. It seems to be a mistake, too, to crowd so great a proportion of the business into one day, as was done on Wednesday. Three sessions of several hours each, filled up with the reading of engineering papers and discussions, furnish rather heavy mental diet for even a vigorous digestion.

The great enemy of meetings of this kind is the temptation of excursions. Some line should be distinctly drawn, and it should be made a rule that it should never be crossed. The morning of every day of the session should be strictly devoted to the business and work of the Society, and nothing should be allowed to interfere with it. Unless such a rule is established and adhered to, there will be, each year, some special occasion for ignoring what is the real occasion for the existence of the Society, and for devoting the precious time of the session to what is alluring and pleasant, but which is sure in time to undermine the organization. An afternoon excursion or visit is a pleasant diversion after a morning of papers, which are often not light reading ; whereas a whole day's work or a whole day's play is too often tiresome.

IRRIGATION.

THERE are few subjects which just at present occupy a larger share of public attention than that of the artificial supply of water to the lands extending through a large belt in the Western States and territories, where the rainfall is not sufficient or does not come in the right season to make the raising of crops without irrigation possible or profitable. Projects for the improvement of sections of this region abound, and seem to offer excellent investments for capital ; and it is very probable that in the course of the next few years a large amount of money will be expended in this way.

It is quite possible, however, that a considerable portion of this money will be wasted or spent in such a way as to realize only a part of the benefits that might be secured, and while there is undoubtedly a large field open, it is necessary to be very careful, if we would secure the greatest possible benefits from its development.

Attention is called to this by an article in the March number of the *Century Magazine*, written by Major J. W. Powell, the Chief of the Geological Survey, who has had abundant opportunities of studying this subject, and who has probably a more systematic and thorough knowledge of the capabilities of the Western country than almost any other man, so that what he has to say upon the subject is well worth listening to.

There is no doubt that a large part of the land included in the so-called Arid or Desert Belt of the West is capable of raising profitable crops under proper conditions, and there is little doubt also that the total rainfall of that region, supplemented by the melting snows from the mountain ranges, is sufficient to fertilize the land if properly applied. In some portions of it the rainfall is sufficient in amount, but does not come at the proper season, while in others, where the amount falling on a given area is not great enough, there are adjoining barren or rocky districts, the rainfall from which can be collected and applied to the better lands. That this should be done in the most economical manner is really to the interest of the whole country.

Two things are to be considered in any irrigation project : The nature of the land and the nature and sources of the water-supply. There are some kinds of soil on which irrigation would be useless, and there are some locations where the land may be good and water available, yet the climate may be such as to make its cultivation unprofitable, as, for instance, on high plateaus or in mountain valleys, where late and early frosts frequently occur, and where other conditions may intervene to prevent the proper ripening of grain or fruits. The danger is in this case, as in many others, of the too hasty assumption that all irrigation will be profitable, and that all that is necessary is to have water and land and to apply one to the other.

It must be remembered that while there are many instances in which small areas of land can be supplied with water from wells or local springs, in a great majority of cases the proper utilization of water for this purpose requires so considerable an expenditure of capital that it can only be done by corporations either formed by local landowners or organized for the purpose of making a profit by selling the water. This has been done successfully in some cases, especially in California and Arizona, and both systems will probably be extended rapidly during the next few years ; and here may arise further danger in the conflict of rights of different owners and in the waste or misapplication of water owing to bad methods and want of system. In many cases storage reservoirs will be needed for supply during the dry season, and these must often be placed at considerable distances from the points where the water is to be used. In others, where water may be drawn from a river or stream at different points and by different owners, a proper system of storage can only be secured by a union of private interests, which it is not always easy to obtain voluntarily. Again, it is possible for a district on the lower part of a river to be deprived of its just rights by the action of those controlling the head-waters, and, in short, there are a great number of cases in which injustice

may be done or natural resources wasted and thrown away largely from the ignorance of want of consideration.

It is evident that the great need of the so-called Arid Region is a general system of regulation of water rights. Under the present condition of things this can only be done by the General Government, under whose direct control a considerable part of the territory still is. The State of Colorado has a system of water laws which are said, by those familiar with the subject, to be the best in existence, but elsewhere disputes are already arising, and the condition of the law is such that much injustice is possible. Probably the most that the Government can be expected to do is to complete the explorations which have been undertaken by the Geological Survey with special reference to irrigation, and to provide a general law for the territories which may serve as a model for State action. It will, no doubt, be asked to go further and to undertake at certain points the construction of dams and other works to provide storage reservoirs, and generally to assist in reclaiming this region. Whether it will be wise for the Government to undertake this is a question which admits of a great deal of doubt, and any movement in this direction will be strongly opposed. But there is no doubt that the regulation of the subject by law is much needed, and that action should be taken as soon as possible.

NEW PUBLICATIONS.

The Human Beast of Burden: by Otis T. Mason, Curator of the Department of Ethnology, National Museum. Washington; published by the Smithsonian Institution.

This book is curious and interesting from the showing it makes of the contrast between primitive methods of transportation and our present ones. It is an investigation into the extent to which man himself has acted as a carrier, and the capacity which he has shown as a bearer of burdens. It seems strange to us, but it is nevertheless true, that there is a large part of the world in which men and women are the chief, if not the only, beasts of burden, and that no inconsiderable part of the world's freight is carried on their shoulders. Even in our own country burdens are still carried and, to go no further, one can meet any day the peddler with his pack, usually a pretty heavy load. In fact, the loads which a man can learn to carry are almost incredible to those who have not seen them.

The Revised Pocket Geologist and Mineralogist; or, Sixteen Chapters on Coal, Oil, Ores and Other Minerals, for Practical People: by Frederick H. Smith. Baltimore, Md.; published by the Author.

This is a revision and a combination of two former volumes by the Author, who is a well-known engineer and geologist, and is carefully revised to bring it up to date. It is of small size, convenient to be carried in the pocket, and contains 208 pages of reading matter, accompanied by a full and carefully prepared index. It is not, as may be supposed from its limited size, a complete or scientific treatise on geology, but it is what it professes to be, and that is an exceedingly convenient hand-book for engineers and others engaged in explorations in the field. The object has been to avoid as far as possible purely scientific dissertations, and to make the hand-book practical and easily understood. The 16 chapters include one on Bottom Facts which is introductory and explanatory, while the others are on Coal Measures; Oil and Gas; Iron and Manganese Ores; Gold and Silver Ores; Copper and Tin Ores; Lead and Zinc Ores; Nickel, Cobalt and Chrome Ores; Antimony, Mercury, Platinum and other metals; Gems and Precious Stones; Ornamental and Building Stones; Cements and Clays; Salts and Fertilizers; Mineral Paints; Grits and Spars; Other Valuable Minerals.

This table of contents will give some idea of the general scope of the book, and will also show that it has been necessary to condense as much as possible the information given in order to cover the wide range of subjects. While those who make geology a study will probably require more elaborate books, there are none that will be found more practically useful in this direction.

Driving Road Chart of the Country Surrounding New York City. New York; William M. Goldthwaite, No. 107 Nassau Street.

This is an excellent specimen of a good local map; how useful such a map may be—outside of the special purpose for which this is intended—many of our readers can tell from experience, both of use and of trouble caused by the lack of one.

The present map shows the country to a distance approximately covered by a circle of 20 miles radius, with the City Hall in New York as a center, showing within those limits not only all the towns, villages, railroads, and streams, but all the roads and very many of the houses outside of the towns. It is clearly engraved and on a scale large enough to avoid confusion or indistinctness through the use of too small lettering. For convenience in consultation and to avoid the necessity of spreading out too large a sheet, it is mounted in four sheets, the first showing the country west of the Hudson from Fort Lee to Haverstraw and as far west as Pompton in New Jersey; the second, New Jersey as far south as New Brunswick and as far west as Montclair, with the whole of Staten Island; the third, Long Island as far east as Hempstead; the fourth, the upper part of the City itself, Westchester County up to Sing Sing, and the towns of Greenwich and Stamford in Connecticut. It thus includes nearly all the country closely connected with New York, and about all that can be conveniently covered in a day's drive in either direction. The four sheets are mounted in a handsome leather case of convenient size to be carried.

Altogether this map leaves little to be desired, and the multiplication of such maps will be a service to engineers and many others.

BOOKS RECEIVED.

Institution of Mechanical Engineers: Proceedings, October, 1890. London, England; published by the Institution.

Seventeenth Annual Report of the Newport Water Works to the Board of Councilmen for the Year ending December 31, 1889. Newport, Ky.; published for the Trustees.

Seventh Annual Report of the Board of Railroad Commissioners of the State of New York for the Fiscal Year ending September 30, 1889; Volume II: William E. Rogers, Isaac V. Baker, Jr., Michael Rickard, Commissioners. Albany, N. Y.; State Printer.

Papers Read before the Engineering Society of the School of Practical Science, Toronto: Edited by the Committee on Publication. Toronto, Ont.; published for the Society.

Report on the Extent of the First Works to be Constructed for Supplying Water to Syracuse, N. Y.: by J. J. R. Croes, C.E. New York; the *Engineering and Building Record* Press.

Statistical Abstract of the United States; 1889, Twelfth Number: Prepared by the Bureau of Statistics under the Direction of the Secretary of the Treasury. Washington; Government Printing Office. This number of

the Abstract gives statistics relating to Finance, Coinage, Commerce, Immigration, Shipping, Postal Service, Population, Railroads and Agriculture.

SIXTH ANNUAL REPORT OF THE PHILADELPHIA COMPANY, FOR THE YEAR ENDING MARCH 31, 1890. Pittsburgh, Pa.; issued by the Company. This report gives the reader some idea of the extent of the use of natural gas in Pittsburgh. The Philadelphia Company now owns 201 producing gas wells and 703.23 miles of pipe lines. Its gross earnings last year amounted to $3,162,150 and the net earnings to $1,631,721, leaving a profit sufficient to pay dividends of 7 per cent., besides large payments for extension of plant and reduction of debt.

REPORTS OF THE CONSULS OF THE UNITED STATES; NO. 114, MARCH, 1890: PREPARED BY THE BUREAU OF STATISTICS, DEPARTMENT OF STATE. Washington; Government Printing Office.

CORNELL UNIVERSITY, COLLEGE OF AGRICULTURE: BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION, MARCH, 1890. Ithaca, N. Y.; published by the University.

A TEST OF THE EFFICIENCY OF A WESTINGHOUSE ALTERNATING CURRENT ELECTRIC LIGHTING PLANT: BY HAROLD P. BROWNE. New York.

THE SEWER GAS QUESTION: BY E. S. MCCLELLAN, M.D. New York; issued by the Du Bois Manufacturing Company.

THE PELTON WATER-WHEEL: ILLUSTRATED CATALOGUE AND DESCRIPTION. San Francisco, Cal.; issued by the Pelton Water-Wheel Company.

DIRECTORY OF PATENT SOLICITORS: VOLUME I, NO. 1, APRIL, 1890. New York; E. de V. Vermont. This directory purports to give a list of patent lawyers, patent experts, patent agents, pattern and model makers, designers and draftsmen, trade papers, technical publishers and manufacturers specially interested in new inventions—a pretty comprehensive undertaking. It will be issued quarterly.

THE RICHARDSON BALANCED SLIDE VALVE: ILLUSTRATED CATALOGUE AND DESCRIPTION. Troy, N. Y.; issued by the Estate of F. W. Richardson, H. G. Hammett, Manager.

TAUNTON LOCOMOTIVE MANUFACTURING COMPANY, BOILER DEPARTMENT: ILLUSTRATED CATALOGUE AND ANNOUNCEMENT FOR 1890. Taunton, Mass.; issued by the Company.

ABOUT BOOKS AND PERIODICALS.

THE last quarterly number of the PROCEEDINGS of the United States Naval Institute is given up entirely to the report of the Naval Policy Board, which has, of course, great interest for naval officers, and which is likely to call out much discussion among them.

The third of Major Powell's articles on Irrigation appears in the May CENTURY, and treats of the legislation and regulations needed to control water rights in the irrigation districts—a timely and important paper.

The Engineering Society of the State University of Iowa has issued the April number of the TRANSIT, its official paper, in excellent style. It is well printed and contains several excellent papers, notably one on Tests of Iron and Steel, one on the Sewerage of Iowa City, and one on the Location of Bridges. The TRANSIT is certainly a credit to the Society.

In OUTING for May the second part of the paper on the Alabama State Troops is given. There are several papers on Yachting, with illustrations of some noted English boats, and other timely spring articles.

The AMERICAN MACHINIST has increased its size from 16 to 20 pages—an evidence of well-deserved prosperity which it is very pleasant to see.

In the JOURNAL of the Military Service Institution for May will be found the second part of Lieutenant Bush's Development of Submarine Mines and Torpedoes. Other articles include Infantry Drill, by Lieutenant-Colonel Hawkins; Artillery during the Rebellion, by Captain Hubbell; Practical Work for Infantry, by Lieutenant Avis; the Military Situation in France, by Lieutenant Lockwood; a Regimental Court of Honor, by Lieutenant Wills, and the usual translations and current notes.

In the ARENA for May there is a paper of more than ordinary interest on Rock Gases, by Professor N. S. Shaler. Mr. John H. Keatley gives an account of the Gold Fields of Alaska in which he speaks from actual observation in that little known territory.

In the OVERLAND MONTHLY for May Mr. Vassault brings out strongly the fallacies of Senator Stanford's plan for the relief of farmers. The second part of Mr. Hallidie's Study of Skilled Labor Organizations is a very good paper; there is also a curious article on Chinese Education and Western Science, by Kaw Hong Ben, showing the views of the small progressive element in China.

THE BROOKLYN DRY-DOCK.

THE great dry-dock at the Brooklyn Navy Yard was opened on May 10, the first vessel to enter it being the *Puritan*. The dock was built by J. E. Simpson & Company, on the plan devised by Mr. Simpson, which has proved very successful.

The construction of this dock was commenced in December, 1887. The time limit expressed in the contract was 24 calendar months, but many difficult engineering problems were encountered, otherwise the structure would have been ready to receive a vessel last July. This dock is built upon pile foundations throughout, the floor piling being driven in rows, spaced 3 ft. between centers transversely and 4 ft. longitudinally, upon which heavy fore-and-aft timbers of Georgia pine are fitted longitudinally. Upon these fore-and-aft timbers, placed transversely, 4 ft. between centers, are firmly secured heavy Georgia pine floor timbers. Upon these floor timbers are laid longitudinally Georgia pine planking, thus forming the working floor.

The keel blocks are additionally supported by four rows of piles, and capped with heavy Georgia pine timber, running fore-and-aft of the dock. The heads of all foundation piles are also enclosed in a continuous bed of Portland cement concrete, which concrete also fills all spaces between timbers, and rises to the planking or working floor. Open concrete drains or sluiceways are provided on each side of the keel way beneath the floor timbers leading to the drainage or culvert and well, near the entrance of the dock. The sides and head of the dock have an inclination of about 45°; the altars or steps are all of Georgia pine timber, having a rise of 8 in. and 10 in. tread, securely bolted to side-brace timbers, which are supported by piles and abut upon the ends of the floor timbers. The altars are backed with clay puddle as the sides are built up, and the five upper courses of altars and the coping are thoroughly treated with wood-creosote oil. The bilge blocks slide upon oak bearers placed upon every third floor timber.

The iron caisson for closing the dock bears against rubber packing attached to sill and abutments the whole length of the keel and stem, no grooves being used. Two gate and caisson sills are provided, the outer one for use in repairing the main or inner sill. Means of ingress or egress are provided by the continuous altars or steps of the dock, thus materially aiding dispatch and economy in the work of repairs to vessels occupying the dock.

The dimensions of this dock are as follows: Length over all on coping, 530 ft.; length over all inside of caisson, 500 ft.; width on top amidship, 130 ft.; width on floor amidship, 50 ft.; width on floor at entrance, 53 ft.; width on top at entrance, 85 ft.; depth of gate sill below coping, 50 ft. 6 in.; depth of gate sill below high water, 25 ft. 6 in.

The machinery for operating the dock consists of two centrifugal pumps, each 42 in. in diameter, driven by two

vertical engines 28 in. diameter of cylinder by 24 in. stroke, with adjustable cut-offs, steam power being furnished by three steel boilers 13 ft. diameter and 11 ft. long. The entire pumping plant was furnished by the Southwark Foundry & Machine Company, of Philadelphia. These pumps have a capacity of over 80,000 gallons per minute, enabling the dock to be emptied of water (without a vessel) in about 90 minutes, and with a vessel of moderate displacement in much less time. The dock is filled by means of culverts running through the caisson; there are eight flood gates, each 22 in. in diameter, operated by hand wheels on pump back of caisson. The contract price for the dock complete was $565,893.

In addition to a number of docks built for private parties, Messrs. J. E. Simpson & Company last year completed one at the Norfolk Navy Yard, and they are now building another for the Government at League Island on the Delaware.

TRANSITION, OR EASEMENT CURVES.

To the Editor of the Railroad and Engineering Journal:

LET $A\,B$, fig. 1, be a simple curve of degree D connecting the tangents $A\,V$ and $B\,V$, the ends of which are to be replaced by transition curves beginning on the same tangents and ending at a given number of chains from A and B.

Suppose, for example, $A\,P_2$ to be two chains in length, and suppose it replaced by a transition curve $A'\,P\,P_1\,P_2$ beginning at A', a chain back of A. Let x, y, and z represent the degrees or central angles of the three branches of the transition curve.

We have $x + y + z = 2\,D$ (1).

Since the inclination of the chords $A\,P$, $P\,P_1$, and $P_1\,P_2$ to the tangent $A\,A'$ are $\frac{1}{2}x$, $x + \frac{1}{2}y$, $x + y + \frac{1}{2}z$, we have

$$A\,P = c \sin. \tfrac{1}{2} x$$

$$t_1\,P_1 = c\left(\sin. \tfrac{1}{2} x + \sin. (x + \tfrac{1}{2} y)\right)$$

$$t_2\,P_2 = c\left(\sin\ \tfrac{1}{2} x + \sin. (x + \tfrac{1}{2} y) + \sin. (x + y + \tfrac{1}{2} z)\right) \quad (2).$$

K being the point on the D-degree curve one chain from A (just above P_1), we have

$$t_1\,K = c \sin. \tfrac{1}{2} D$$

$$t_2\,P_2 = c\,(\sin. \tfrac{1}{2} D + \sin. \tfrac{3}{2} D) \quad (3).$$

We may, in equations (2) and (3), suppose the sines to vary as the arcs, since the terms are small, and since, too, the terms of equation (3) are nearly equal to the corresponding terms in equation (2). This supposition gives

$$\tfrac{1}{2} x + (x + \tfrac{1}{2} y) + (x + y + \tfrac{1}{2} z) = \tfrac{1}{2} D + \tfrac{3}{2} D \quad (4).$$

Now, since we have three independent quantities, x, y, and z, and only two equations connecting them, we may make any assumption in regard to them. We will assume that x, y, and z are in arithmetical progression, or that

$$2\,y = x + z \quad (5).$$

Eliminating z from equations (1) and (2), and from (1) and (3), we find

$$x + \tfrac{1}{2} y = \tfrac{1}{2} D, \text{ or } 2\,x + y = D \quad (6)$$

and $\quad y = \tfrac{4}{6} D \quad$ (7).

Now (4) gives $\quad x = \tfrac{1}{6} D \quad$ (8)

and $\quad z = \tfrac{7}{6} D \quad$ (9).

Since $x + \frac{1}{2} y$ measures the arc from A' to the middle of $P\,P_1$, and $\frac{1}{2} D$ measures the arc from A to the middle of $A\,K$, it follows that the chords $P\,P_1$ and $A\,K$ are parallel, and that the points P and P_1 are equally distant from the original curve. This facilitates the laying out of the curve. Since the deflection angles from the tangent at P_2 to P_1 is $\frac{7}{12} D$, and to K is $\frac{6}{12} D$, we have

$$K\,P_1 = A\ P = P_2\,P_1 \sin. \tfrac{1}{12} D.$$

Hence the degrees of the three branches of a transition curve to replace a 6° curve are $\frac{1}{6} \times 6° = 1°$, $\frac{4}{6} \times 6° = 4°$, and $\frac{7}{6} \times 6° = 7°$.

To replace a 13° curve the degrees of the branches are, $\frac{1}{6} \times 13° = 2°\ 10'$, $\frac{4}{6} \times 13° = 8°\ 40'$, $\frac{7}{6} \times 13° = 15°\ 10'$, etc. Of course the chains or chords may be of any length, and it is not necessary, but convenient, to have them of equal length.

Substituting the above values of x, y, and z in equation (2), and subtracting equation (3) from it, and representing the difference by d, we have

$$d = c\,(\sin. \tfrac{1}{12} D + \sin. \tfrac{17}{12} D - \sin. \tfrac{18}{12} D)$$

$$= c\,(\sin. \tfrac{1}{12} D - (\sin. \tfrac{18}{12} D - \sin. \tfrac{17}{12} D) \quad (11).$$

Since d is very small, but positive, we see that running the transition curve from P_2 toward A', the end of such curve would fall slightly above the tangent ($A\ V$) to the original curve. For rather an extreme case, suppose $D = 12°$, the central angle $A\ O\ P_2$ being 24°, and c being 100 ft., we have

$$d = 1.745 + 29.237 - 30.902 = .08 \text{ ft.}$$

If $D = 6°$, we have

$$d = 100\,(\sin. 30' + \sin. 8°\ 30' - \sin. 9°)$$

$$= .873 + 14.781 - 15.643 = .01 \text{ nearly.}$$

The curve necessarily ends on the tangent $A\ V$, fig. 1, or on $A'\ A$ fig. 2; fig. 2 being an exaggerated view of a part of fig. 1, the same letters on both figures referring to

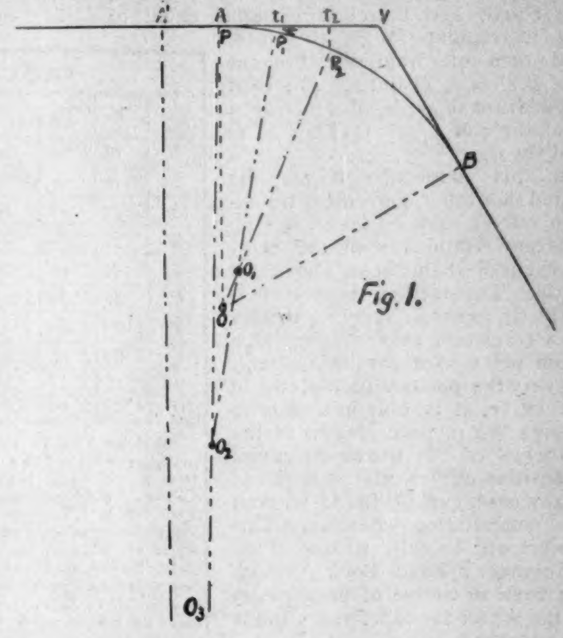


Fig. 1.

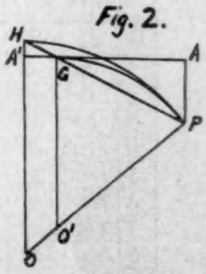


Fig. 2.

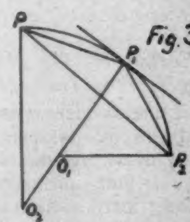


Fig. 3.

the same parts. We may run the curve from P to G, the deflection angle at P being, of course, the same as for the curve $P\,H$, namely, $\frac{1}{12} D$, the angle at O' being equal to the angle at O—that is, to $\frac{1}{6} D$. The chord $P\,G$ being less than $P\,H$ and the radius $P\,O'$ less than $P\ O$, the degree of the branch $P\,G$ is greater than that of $P\,H$, viz., $\frac{1}{6} D$. Knowing $A'\,H$, $P\,A$, and $H\,P = c = 100$ (say), $H\,G$ or $G\,P$ is easily found by similar triangles; but it is not necessary to consider them. Of course the curve ends at A' instead of at G, which has no effect except to slightly lengthen and flatten the curve $P\ G$, making, to that extent, a transition curve of it.

To lay out the curve, suppose $A\ K\ P_2$ to be located. Then, since at P_2 the deflection for the curve $A\ K\ P_2$ is $\frac{1}{2} D$, and the deflection for the curve $A\ P_1\ P_2$ is $\frac{1}{2}\,(\frac{7}{6} D)$, the difference is equal to $\frac{1}{12} D$. P_1 is therefore inside of K a distance equal to $c \sin. \frac{1}{12} D$. Moreover, by the first assumption the chords $P\,P_1$ and $A\,K$ are parallel, therefore P is likewise inside of A a distance equal to $c \sin. \frac{1}{12} D$. Set P and P_1, therefore, each at a distance c sin.

$\frac{1}{12}D$, from A and K respectively, and A' on the tangent $A\ V$ and a chain from A.

Example 1. It is required to substitute a transition curve three chains in length in place of two chains of a 5° curve. We have $\frac{1}{12}D = 25'$ and 100 sin. $25' = .727$. Set P and P_1 .727 of a foot inside of A and K and A' on the tangent one chain from P.

Example 2. To replace four chains of a 7° curve with a transition curve six chains in length: $\frac{1}{12}D = 35'$. Let $P_2 P_1 = P_1 P = P A = 2$ chains. Then $K P_1 = A P =$ 200 sin. $35' = 2.036$ ft. This gives the position of P_1, P and A', and the intermediate stations can be set by middle ordinates at a distance 6.1 ft. from the middle of the chords.

To lay out a transition curve with the insrument: We observe that the chords $P P_1$ and $P_1 P_2$, in fig. 3, being perpendicular to the radii bisecting them, the angle between either chord and the prolongation of the other is equal to half the sum of the central angles O_1 and O_2 or to $\frac{1}{2}(\frac{7}{6}D + \frac{4}{6}D) = \frac{11}{12}D$. But the angles at P and P_2 are equal, and therefore either is equal to $\frac{11}{24}D$. Set the instrument at P_2, therefore, and turn off from the tangent $\frac{1}{2} \times \frac{7}{6}D = \frac{7}{12}D$ and set P_1; then an additional angle of $\frac{11}{24}D$ or a total angle of $(\frac{7}{12} + \frac{11}{24})D = \frac{25}{24}D$ and set P.

In this connection it may be stated that other convenient transition curves may be found having different relations with the original curve than those above set forth. The method explained is perfectly general, applying readily to a transition curve ending at a given point on a parallel tangent. To vary the position of the end of the curve, it is only necessary to change the relative lengths of the branches of the transition curve. Transition curves, just as required in any case, can be found without any computation whatever. This subject will be fully treated in the "Engineer's Field Book," which has been in course of preparation by the writer for some years and is far advanced.

P. H. PHILBRICK,
Chief Engineer Kansas City, Watkins & Gulf Railroad.

To the Editor of the Railroad and Engineering Journal:

THAT the use of easement curves in railroad practice is desirable is admitted by most engineers. But it is a singular fact that those who advocate their introduction are frequently denounced as mere theorists by those who are unwilling to take the trouble to use them. Others condemn the use of the easement curves on the ground that it is impossible to retrace them after the original points are lost. In this connection I shall introduce an extract from a letter which recently appeared in the *Railroad Gazette* over the signature of Mr. William H. Brown, Chief Engineer of the Pennsylvania Railroad Company, as follows, viz.: "The elastic curve theory is all very nice in an office or college class-room, but I will venture to say that the people who are so enthusiastic in regard to this matter could not turn the curve twice in the same place on the ground." Now this may apply to instances where the subject has been treated from a purely theoretical standpoint, but I am one of those enthusiasts who believe that the subject admits of a simple and practical solution. I therefore have no hesitancy in submitting the table for spiralizing curves used on this road, together with diagram and explanation, and will venture to say that no competent transitman will meet with any difficulty in applying the same in the field. Neither will any competent transitman have any difficulty in retracing the curves as originally run, even if the original points be lost. Mr. Brown, in the letter referred to, advocates the use of 30-minute curves at the ends of all curves to ease the shock of trains at the tangent points, giving as his reason that while a curve of this kind answers every purpose, it "can be retraced by any person who can run a transit, even if the point of tangent is lost." I am unwilling to admit that this method of easement "answers every purpose," for I cannot see how a 30-minute curve compounding abruptly into a curve of shorter radius can dispose of the shock so effectually as the spiral curve. The method of spiralizing curves explained in the table has given excellent satisfaction wherever used, and I can see no objection to its use from either a theoretical or practical standpoint. It may be stated that shorter chords may be used if deemed advisable, or on account of sharp curves or short tangents.

FRANKLIN RIFFLE,
Chief Engineer Oregon & Washington Territory Railroad.

TABLE FOR SPIRALIZING CURVES.

TABLE OF DEFLECTIONS, P.S' TO P.T. CHORD = 30 FT.

D	1.	2	3	4	5	6	7	8	9	10	
1	06'	2									03'
2	15'	24'	3								12'
3	24'	42'	54'	4							27'
4	33'	1° 00'	1° 21'	1° 36'	5						48'
5	42'	1° 18'	1° 48	2° 12°	2° 30'	6					1° 15'
6	51'	1° 36'	2° 15'	2° 48'	3° 15'	3° 36'	7				1° 48'
7	1° 00'	1° 54'	2° 42'	3° 24'	4° 00'	4° 30'	4° 54'	8			2° 27'
8	1° 09'	2° 12'	3° 09'	4° 00'	4° 45'	5° 24'	5° 57'	6° 24'	9		3° 12'
9	1° 18'	2° 30'	3° 36'	4° 36'	5° 30'	6° 18'	7° 00'	7° 36'	8° 06'	10	4° 03'
10	1° 27'	2° 48'	4° 03'	5° 12'	6° 15'	7° 12'	8° 03'	8° 48'	9° 27'	10° 00	5°

Deflections in digonal column are used in running Spiral from P.S. to P.C.

EXPLANATION OF TABLE.

Look in Column D for ° of curve; the first deflection on that line will be the deflection from tangent for Chord point 1; the second for point 2, and so on until the number of points set will = D.

The last one will be the P. T.

TO CONNECT TWO TANGENTS WITH A CURVE, USING SPIRALS.— Set instrument at the P.I. and measure angle. Take Tangent corresponding to this angle from table of tangents to 1° curve. Divide by D (= degree of curve); to quotient add correction in column C, and measure this distance along each tangent to set P.S. & P.T. Move instrument to P.S. and to set any point on Spiral we have (z^2+3') = deflection from Tangent. To set P.C. turn from Tangent $\frac{\Delta}{3}$. To turn Tangent at P.C., backsight on P.S. and turn $\frac{2\Delta}{3}$, calculate deflections for shortened radius, and put in Circular Curve. Central Δ of Circular Curve = $I - 2\Delta$. Move instrument to P.S', and to set any point on Spiral we have $(D \times 9z - 3z^2)$ = Deflection in minutes from Tangent at P.S.' to any point on Spiral. The last deflection will be $\frac{2\Delta}{3}$. Move instrument to P.T. and backsight on P.S.', turn $\frac{\Delta}{3}$ and instrument will indicate succeeding Tangent.

SPIRAL TABLE.— LENGTH OF STANDARD SUB-CHORD = 30 FT.

D.	l.	S.	N.	Δ.	C.	Co-Ordinates.		Long Chords.	Radius.	D.
1	30'	.01'	1	09'	15.00'	.026	30.000	30.000	5,729.64	1
2	60'	.05'	2	36'	30.00'	.209	59.999	60.000	2,864.88	2
3	90'	.18'	3	1° 21'	45.00'	.706	89.995	90.000	1,909.90	3
4	120'	.42'	4	2° 24'	60.00'	1.674	119.979	119.990	1,432.27	4
5	150'	.82'	5	3° 45'	75.04'	3.270	149.936	149.970	1,145.46	5
6	180'	1.41'	6	5° 24'	90.08'	5.650	179.841	179.930	953.96	6
7	210'	2.25'	7	7° 21'	105.18'	8.968	209.657	209.740	816.77	7
8	240'	3.34'	8	9° 36'	120.35'	13.376	239.331	239.627	713.44	8
9	270'	4.77'	9	12° 09'	135.67'	19.023	268.795	269.470	632.50	9
10	300'	6.54'	10	15° 00'	151.14'	26.052	297.960	299.110	567.15	10

Let D = degree of Circular Curve.
" l = Length of Spiral.
" I = Intersection Angle.
" S = Shift of Circular Curve
" C = amount to be added to Tangent to set P.S. or P.T. from P.I.

Let Δ = Cent. angle of Spiral.
" Z = No. of any Chord point.
" N = No of chords in Spiral.
Length of Standard Chord = 30'

$\Delta = (9D^2)$ $S = \frac{82^2 D}{1,600,000}$

Length of Spiral = $D \times 30' = l$.

Ex. Secant of spiralized curve = Ex. Secant of Circular Curves + S.

Let the Chord points be numbered from P.S. to P.C., calling P.S. 0, and from P.S' to P.C., calling P.S.' 0.

R = Radius of Circular Curve. R − S = R'

R' = " " Spiralized Curve.

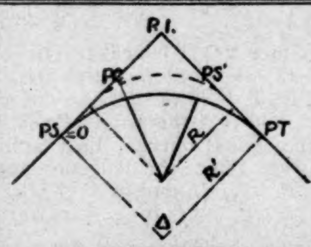


DIAGRAM.

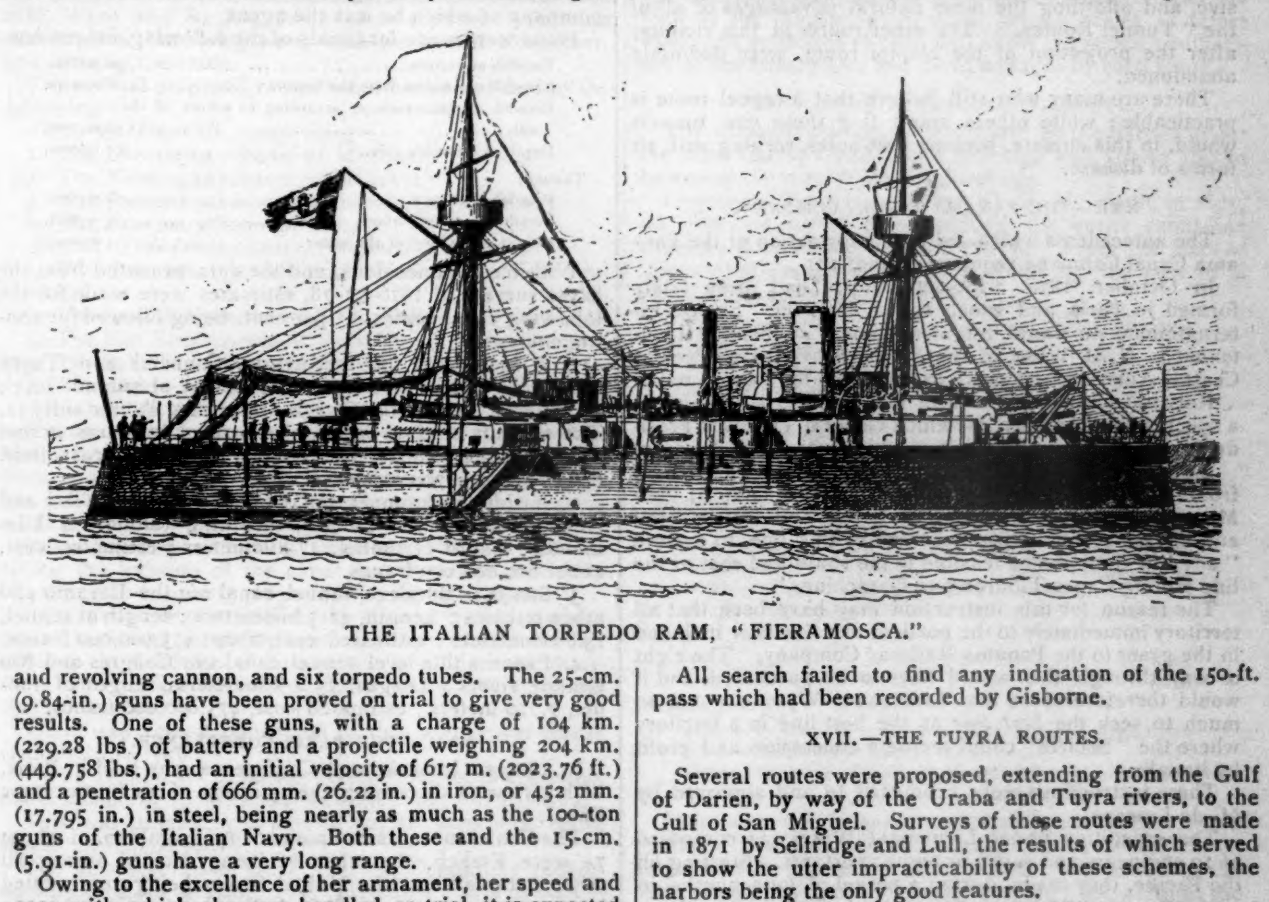
THE LATEST ITALIAN CRUISER.

THE latest addition to the Italian Navy is the *Fieramosca*, which is classed as a "torpedo ram," and which has been recently completed, the plans having been prepared under the direction of Commandante Vigna. The accompanying illustration, from *Le Yacht*, is a general view of the vessel.

The *Fieramosca* is 88.40 m. (289.95 ft.) in length; 13.20 m. (43.296 ft.) in width; has an extreme draft of 5.90 m. (19.35 ft.) and a displacement of 3,745 tons. She has two screws, each driven by a separate engine, and on the trial trip obtained a speed of 18.6 knots per hour, the engines developing 7,500 H.P. The hull is entirely of steel, and the machinery and magazines are protected by a heavy armored deck. The coal capacity of the bunkers is 590 tons.

The main battery includes two 25-cm. (9 84-in.) guns, weighing 25 tons, each mounted in pivot, one forward and the other aft, and six 15-cm. (5.90-in.) guns mounted in draw side. There is a secondary battery of machine guns and revolving cannon, and six torpedo tubes. The 25-cm. (9.84-in.) guns have been proved on trial to give very good results. One of these guns, with a charge of 104 km. (229.28 lbs) of battery and a projectile weighing 204 km. (449.758 lbs.), had an initial velocity of 617 m. (2023.76 ft.) and a penetration of 666 mm. (26.22 in.) in iron, or 452 mm. (17.795 in.) in steel, being nearly as much as the 100-ton guns of the Italian Navy. Both these and the 15-cm. (5.91-in.) guns have a very long range.

Owing to the excellence of her armament, her speed and ease with which she was handled on trial, it is expected that this ship will be very formidable in action—more so, perhaps, than some of the very heavy battle-ships for which the Italians have shown a preference heretofore.



THE ITALIAN TORPEDO RAM, "FIERAMOSCA."

INTEROCEANIC COMMUNICATION BY WAY OF THE AMERICAN ISTHMUS.

BY LIEUTENANT HENRY H. BARROLL, U.S.N.

(*Continued from page 206.*)

XV.—THE ISTHMUS OF DARIEN.

THE Isthmus of Darien, situated south of the Isthmus of Panama, has long been regarded as the most prominent section for canal construction.

Notwithstanding the failure of the early attempts under Mr. Kelley and others, the United States Government has paid the closest attention to the examination of this section of the dividing ridge; and it was not until every ravine had been examined, each stream inspected, from its mouth till its waters were lost in the mountain streams, that the Canal Commissioners were satisfied with the examination.

XVI.—THE CALEDONIA BAY—SAN MIGUEL ROUTE.

The numerous early explorations of this route have been alluded to. After the United States Government commenced systematic surveys, the Isthmus of Darien was again explored, in 1870–71–73, by Captain Thomas O. Selfridge, U. S. N.

With regard to this line, two routes were here considered: one from Caledonia Bay, by way of the Savana River, to the Gulf of San Miguel; the other by way of the Sassardi and Morti rivers.

Selfridge's surveys showed for the former a lowest divide of 1,000 ft., with insufficient water for lockage; for the latter a line of levels showed that the Morti River itself, when first struck, had an elevation of over 300 ft.

All search failed to find any indication of the 150-ft. pass which had been recorded by Gisborne.

XVII.—THE TUYRA ROUTES.

Several routes were proposed, extending from the Gulf of Darien, by way of the Uraba and Tuyra rivers, to the Gulf of San Miguel. Surveys of these routes were made in 1871 by Seltridge and Lull, the results of which served to show the utter impracticability of these schemes, the harbors being the only good features.

The length of actual canal here would be 55 miles; and its cost, based upon a system of lockage, with a summit level of 160 ft., would exceed $250,000,000.

XVIII.—THE TRUANDO-ATRATO ROUTE.

This scheme contemplated a canal without locks, the western section of the canal being supplied with water from the Atrato River.

The initial point of the canal, which was also its summit level, was a point on the Atrato River, 32 ft. above the sea-level. It was proposed at this point to divert a portion of the Atrato River through a tunnel 12,250 ft. in length, passing underneath the dividing ridge and striking the Chuparador, proceeding by that river and the Parachuchichi to the Pacific.

Notwithstanding the complicated nature of a canal by this route, its estimated cost was only $134,450,000, and it for some time held the attention of the Canal Commissioners.

XIX.—THE ATRATO-NAPIPI ROUTE.

This route contemplated starting from the Gulf of Darien, ascending the Atrato River for some 140 miles, thence by a lock-canal and tunnel to Chiri Chiri Bay on the Pacific.

Several surveys were made here, in 1870-71-73, by Captain Selfridge, the projector of the route, and later, in 1875, a survey was made by the late Lieutenant Frederick Collins, U. S. N., who located the entire canal line. This route was also presented to the Paris Conference for their consideration, but was not successful in receiving the support of that body, notwithstanding the fact that careful estimates had placed the probable cost of its construction at less than $100,000,000.

XX.—OTHER ROUTES BY WAY OF THE ATRATO.

All other routes which contemplated using the Atrato River were definitely shown to be inferior to the Atrato-Napipi route, which, as finally projected by Selfridge, was clearly shown to be the most practicable, the least expensive, and affording the most natural advantages of all of the "Tunnel Routes." The other routes in this vicinity, after the projection of the Napipi route, were definitely abandoned.

There are many who still believe that a tunnel route is practicable; while others assert that these vast tunnels would, in this climate, become pest-holes, reeking with all forms of disease.

XXI.—THE PANAMA CANAL COMPANY.

The antecedents which led to the formation of the Panama Canal Company require explanation.

In October, 1876, a Society which had been lately formed in Paris, and which styled itself the "Société Internationale du Canal Interoceanique," authorized Lieutenant L. N.-B. Wyse, of the French Navy, to proceed to Central America, and make explorations for a canal route.

Notwithstanding the title of this Society, it was simply a speculative company, of which General Turr was President, and the directing spirit of which was M. de Lesseps.

Lieutenant Wyse was instructed to examine the route from the Gulf of Uraba (Darien) to the Gulf of San Miguel, by way of the Atrato, Carcarica and Paya rivers; and in case of difficulties presented by this line, to explore "any line that seemed feasible to the south and east of the line joining Capes Tiburon and Garachine."

The reason for this instruction may have been that all territory immediately to the north of this line was included in the grant to the Panama Railroad Company. The right of way through this would have to be purchased, and it would therefore seem that Lieutenant Wyse was not so much to seek the *best line* as the best line in a territory where the "Société" could secure a concession and profit by its sale.

These instructions were submitted to and approved by M. de Lesseps.

The expedition under Lieutenant Wyse was composed of 10 engineers and seven or eight assistants. Starting on the Pacific, they made, during a period of four months, in 1876-77, explorations over this route, during which explorations no part of the expedition penetrated to the Atlantic Coast.

Two canals were nevertheless proposed and elaborated. One, a lock-canal, by way of the Tuyra and Caquerri rivers, and another, a tide-level canal, by way of the Tupisa, Tiati and Acanti-Tolo rivers.

The latter route was explored under the personal supervision of Lieutenant Wyse as far as its junction with the Tiati, or only half of the distance which it was proposed to canalize. The remainder of the line was not even reconnoitered; yet M. Wyse felt competent to estimate to within 10 per cent. the cost of a canal here.

In October, 1877, M. Wyse and party again returned, under orders from the same Société, to make further surveys upon this and other possible routes. M. Wyse's special mission, this time, seems to have been the negotiation with the Colombian Government concerning concessions, and in his absence the surveys were under the charge of M. Reclus.

They made surveys across the San Blas-Bayamo route, and also explored several other river valleys. Between April 3 and April 20, 1878, the party ran a line of survey along the route of the Panama Railroad, with a view to the construction of a tide-level tunnel canal. The survey consisted of level lines and cross-sections continued up to the extremities of the proposed tunnel, and did not continue over the divide.

Shortly after this survey of the Panama line had been concluded, M. Wyse returned from Bogota to Panama, having been successful in securing from the Colombian Government a concession covering the whole of the territory of the United States of Colombia, which, therefore, gave the Société exclusive right of way over all of the proposed routes except those of Nicaragua and Tehuantepec; while it was well known, by this time, that a canal by way of the Isthmus of Tehuantepec was impossible.

M. Wyse left Panama for Greytown, Nicaragua, examined that harbor, and had some correspondence with the President of the Republic of Nicaragua, but was evidently not successful in getting control of this canal route for the company of which he was the agent.

Plans were made for canals of the following dimensions:

Breadth at bottom	20 meters.
Breadth at 3 meters from the bottom	26 meters.
Breadth at water-surface, according to nature of the soil	32 to 50 meters.
Depth at mean low tide	8.5 meters.
Tunnel:	
Breadth at bottom	20 meters.
Breadth at water-surface	24 meters.
Height above level of the water	34 meters.

With these dimensions, and the data procured from the Wyse surveys of 1876-77-78, estimates were made for the following canal routes, 25 per cent. being allowed for contingencies:

1. A lock-canal *via* the Atrato, Caquerri and Tuyra rivers: Length, 128 kilometers; height of summit level, 50 meters; locks, Atlantic side, 10; locks, Pacific side, 12. The summit level to be a lake formed by dams across ravines in the valley of the Tuyra. Estimated cost, from 650,000,000 to 700,000,000 francs.
2. A tide-level tunnel canal *via* the Tupisa, Tiati and Acanti-Tolo rivers: Length, including tunnel, 74 kilometers; length of tunnel, 17 kilometers; estimated cost, about 600,000,000 francs.
3. San Blas tide-level tunnel canal *via* the Bayamo and other streams: Length, 41.5 kilometers; length of tunnel, 15.8 kilometers; estimated cost, about 475,000,000 francs.
4. Panama tide-level tunnel canal *via* Chagres and Rio Grande rivers: Length, 73.2 kilometers; length of tunnel, 7,720 meters; estimated cost, 475,000,000 francs.

XXII.—THE PARIS CONFERENCE.

In 1879 an International Conference was held in Paris, with a view to discussing the question of an Interoceanic Canal.

The Conference was composed of 136 members, of whom 74 were French, the other 62 being divided among all other nationalities; the United States being represented by 11 members and the British Empire by six. Among the delegates from the United States were Admiral Daniel Ammen, U. S. N., Commander Thomas O. Selfridge, U. S. N., and Civil Engineer A. G. Menocal, U. S. N.

These three persons were then, and probably are now, the most competent authorities on this subject, each of them having been for years engaged upon surveys of the American Isthmus.

It was from the first plainly to be seen that the majority of the Conference were prejudiced in favor of M. de Lesseps and the Société Internationale, of which General Turr was the President. M. de Lesseps had advised the explorations which had been made by the Society. He was made the President of the Paris Conference, and it was found that he had previously mapped out the work of that body before it had assembled.

Five committees were formed, and one of these, known as the "Technical" Committee, and composed of 42 members, afterward increased to 45 members, was vested with the responsibility of deciding the location of the canal.

Of this committee only two were Americans—only two members from the country through which the proposed canal was to be built!

M. Wyse presented before this Conference a map made from his examinations between April 3 and April 20, 1878, and which was substantially the same as that made by G. M. Totten, the constructor of the Panama Railroad; and this, the "Wyse-Reclus" Canal, first proposed, was that previously mentioned in this article as a tide-level tunnel canal between Aspinwall and Panama.

Mr. Menocal called attention to the immense floods of the Chagres River, and the damage they would do to a tide-level canal.

Sir John Hawkshaw, one of England's ablest engineers, drew attention to the fact that a tide-level canal would receive and must provide for the whole drainage of the district traversed; also that, according to Mr. Menocal's estimates, the volume of the Chagres in the time of flood would much more than fill the proposed tunnel.

Such vital objections were raised to this scheme that it was finally withdrawn, and another scheme introduced by MM. Wyse and Reclus, for a canal between Aspinwall and Panama, but doing away with the tunnel altogether, and altering the route.

The several proposed routes were finally reduced to the following:

First, Lock-canals, comprising:

1. The Nicaragua scheme of Menocal;
2. The Nicaragua scheme of Blanchet;
3. The Panama scheme of Menocal (Lull's route);
4. The Panama scheme of Wyse.

Second, Tide-level canals, comprising:

1. The Panama open-air scheme of MM. Wyse and Reclus;
2. The San Blas scheme of F. M. Kelley;
3. The San Blas scheme of Selfridge;
4. The San Blas scheme of Wyse;
5. The Atrato-Napipi scheme of Selfridge.

All others were rejected.

It must be borne in mind that the Société Internationale had failed to secure a concession of the route *via* Lake Nicaragua; also that Mr. Menocal's scheme at Panama was for a lock-canal, while M. Wyse's scheme at the same point was for a tide-level canal.

Before the committee of 45 members charged with deciding the location of the canal was presented, on May 28, 1879, the following proposition to be voted upon:

"That the committee, from the point of view for which it was instituted, is of the opinion that it should recommend to the Conference the adoption of a tide-level, maritime canal, from the Gulf of Colon, or of Limon, to the Bay of Panama."

There was violent opposition to this, and it was finally remodeled to read:

"The Technical Committee believe that the interoceanic canal should be constructed between Colon and Panama."

This was passed by a vote of 20, 16 members being absent and 9 not voting.

The next resolution, being that the Committee recommended a tide-level canal, was carried by a vote of 16.

The action of this Technical Committee, when presented before the Conference, was sustained by 78 members, 19 of whom were engineers.

On May 29 this peculiar assembly was dissolved.

The Panama Canal Company was now formed, and then followed that strange financial proceeding by which M. de Lesseps attempted to gain the money for the completion of this gigantic work.

Interest was guaranteed on the dormant capital invested during the construction of the canal.

The Company's bonds were sold, bearing interest payable with a part of the money for which they sold, and this money received as interest could be used to purchase other bonds, which bore interest payable from the money received from these last-purchased bonds, etc.

The enthusiastic character of the French people sufficed to enable the Company to raise nearly $400,000,000—over four times the amount that Commander Lull computed as the probable cost of a canal over this route.

After working for some months and seeing the impracticability of constructing a tide-level canal, M. de Lesseps changed the plan, and the last work done upon the Panama Canal was with the view of making a lock-canal.

XXIII.—COMPARISON OF THE DARIEN, PANAMA AND NICARAGUA ROUTES.

It is now seen that the numerous proposed routes have been by careful surveys reduced to three lines, each of which has some characteristic separating it widely from the others:

1. The Atrato-Napipi, with its fine river Atrato and comparatively short canal-line, and three miles of tunnel;
2. The Panama Route, with short distance from ocean to ocean, yet with the unruly Chagres River occupying the only possible line of canal;
3. The Nicaragua Route, with a low profile and with Lake Nicaragua at its summit level, yet with no natural harbors.

Over each of these routes a canal-line has been located, and estimates computed of its probable cost. A brief review of the dimensions of canal prisms, scales of prices used, and estimates of cost, will allow a graphic comparison of the advantages and disadvantages of each route.

XXIV.—THE ATRATO-NAPIPI ROUTE.

The different surveys of this route by the parties under the direction of Commander Selfridge had shown this to be one of the most favorable localities.

Lieutenant Frederick Collins, U. S. N., made, in 1875, an extended survey here, locating the entire canal-line from the Atrato River to the Pacific. From the data of this survey computations were made for the cost of a canal of the following dimensions:

Total length of canal	30.24 miles.
Width at bottom	72 ft.
Width at water-surface in rock	98 ft.
Width at water-surface in earth	150 ft.
Depth, 26 ft.; in tunnel	27 ft.
Slope of sides in earth	1½ base to 1 perpendicular.
Slope of sides in rock below water	1 base to 2 perpendicular.
Slope of sides in rock above water	¼ base to 1 perpendicular.
Embankments:	
Width at top	9 ft.
Interior slope	1½ base to 1 perpendicular.
Exterior slope	2 base to 1 perpendicular.
Width of "bench" at 10 ft. above water-surface	9 ft.
Length of embankments	14 miles.
Locks:	
Width	60 ft.
Length between miter sills	400 ft.
Tunnel:	
Length	3½ miles.
Width at water-surface	70 ft.
Height from bottom of canal to crown of arch	113 ft.
Depth	27 ft.

There were two forms of tunnel proposed by Lieutenant Collins. The first, for solid rock: To be trapezoidal in section, with segmental arch of 120°; the crown of the arch to be 86 ft. above the water-surface; the width at the water-surface to be 70 ft.; depth, 27 ft., and sides below water to be battered 1 to 20. The arch to be formed of masonry 5 ft. thick at the spring and 3 ft. thick at the crown, and backed by concrete.

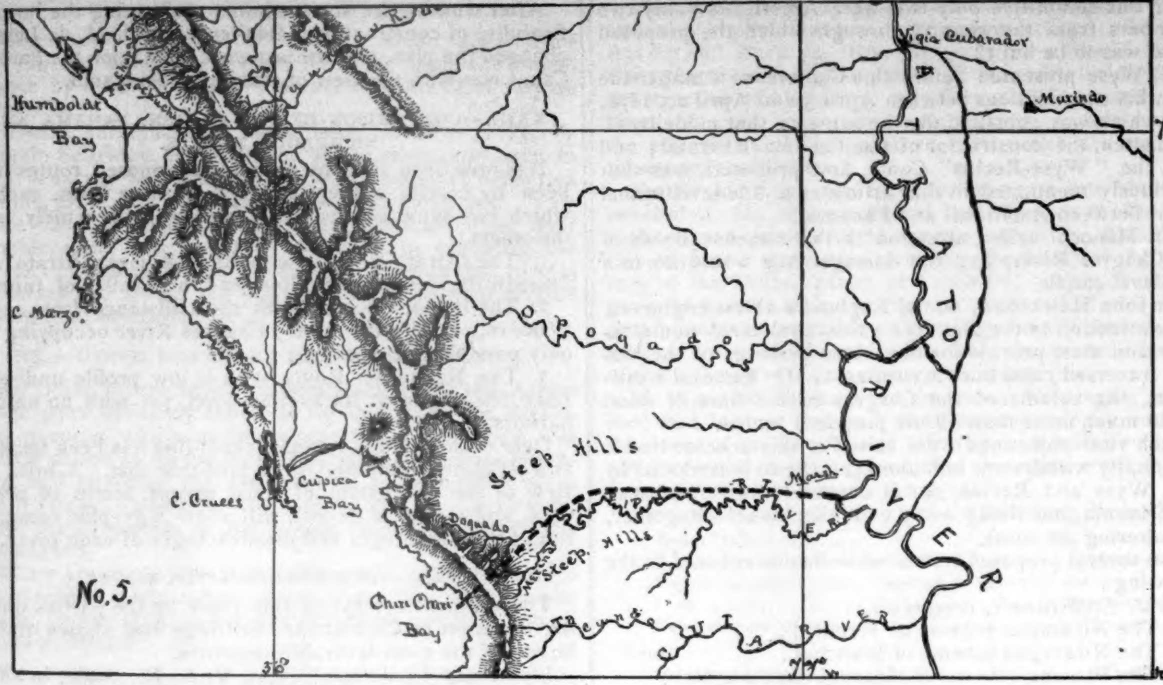
The second, in unsafe or badly seamed rock: The tunnel to be elliptical in section, with conjugate diameter of 70 ft. at the water-surface, and semi-transverse diameter of 86 ft. above water-surface; the section to be continued below, so as to give 27 ft. of water. In this section the arched lining was designed to spring from the water-surface with a thickness of 5 ft., and diminishing to 3 ft. at the crown.

Each section gave 1,846 sq. ft. area of water space.

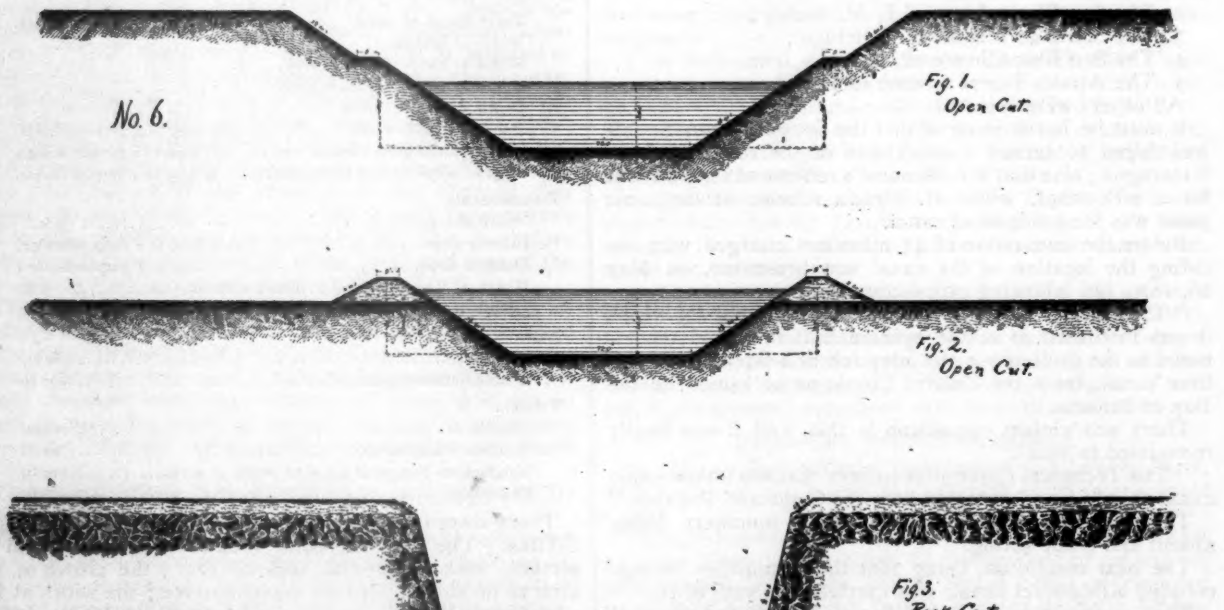
The Trapezoidal plan required: Excavation, 5,279,843 cubic yards; masonry, 203,498 cubic yards; estimated cost of tunnel, $32,479,120.

The Elliptical plan required: Excavation, 5,102,865 cubic yards; masonry, 682,993 cubic yards; estimated cost of tunnel, $40,960,272.

In the final computation of the canal's cost a modified



MAP OF PROPOSED CANAL ON THE ATRATO-NAPIPI ROUTE.



CROSS-SECTIONS OF PROPOSED CANAL ON THE ATRATO-NAPIPI ROUTE.

form of tunnel was considered, being only 60 ft. in width, and the cost of which, taking the mean between the two plans, was $33,241,923.

The water supply of the Napipi and Doguado rivers was further increased by that of the Cuia River. The feeder canal for this was 3½ miles in length, having a fall of 14 ft. in that distance, passing through a tunnel of 9,230 ft. and open cutting of 7,720 ft.

The estimated cost of the feeder canal was $548,726. The daily water supply at lowest stage, from the Napipi, Doguado and Cuia rivers, was found by cross-sections and current meter observations to be 24,000,000 cubic feet.

The following prices were used in computing the cost of this canal: Excavation in earth, 30 to 35 cents per cubic yard; excavation in rock, $1.25 to $1.50 per cubic yard; excavation in tunnel, $5.35 per cubic yard; arched lining of tunnel, $20 per cubic yard; masonry, $15 per cubic yard; dredging, 50 cents per cubic yard; hydraulic concrete, $7 to $8 per cubic yard.

The estimated cost of the canal was:

Excavation and embankment	$28,697,398
Tunnel (as modified, to width of 60 ft.)	33,241,923
Locks	5,049,214
Culverts	3,031,405
Side drains	2,449,953
Diversion of rivers	1,670,159
Dam for crossing Napipi	616,057
Breakwater at Chiri Chiri	2,163,000
Aqueduct	548,726
Improvements, mouth of the Atrato	817,780
Lighthouses	60,000
Grubbing and clearing	191,900
	$78,557,515
Add 25 per cent. for contingencies	19,636,879
Total estimated cost	$98,194,394

The following advantages and disadvantages were enumerated by Lieutenant Collins in his report:

Advantages:

1. Shortness of the artificial channel required (30.24 miles).
2. Good harbors; that on the Atlantic is all that could be desired, while on the Pacific there is good holding-ground, and the region is seldom visited by violent gales.
3. The cutting being mainly in stiff rock or clays, the clay forms stable embankments, little liable to wash from rains or at the water-surface, and its impervious character prevents, in a great degree, loss by filtration or leaks.
4. The greater portion of the work to be performed lies in a healthy region for the tropics.
5. Abundance of good timber for construction.
6. Proximity of the heaviest work to the Pacific Coast, rendering transportation of labor, plant, and supplies comparatively inexpensive.
7. Absence of high winds along the canal-line.
8. Freedom from terrestrial convulsions of a nature likely to affect the permanency of the work.
9. Absence of large streams or of deep valleys to be crossed at a high elevation.
10. Friendly attitude of the inhabitants.
11. Fertility of the soil. Under proper management the country in the vicinity of the canal-line could be made to produce the greater part of the supplies required for the subsistence of the laborers.

Disadvantages:

1. The necessity of resorting to a tunnel, involving great expense in construction, uncertainty in estimates of cost, and a probable increase in the difficulties attending transit, especially for large ships.
2. The steep descent of the Pacific Slope, necessitating the grouping of a large number of locks, and thus increasing the liability of damage to the works.
3. Very heavy cuttings in the valley of the Doguado and Chiri Chiri rivers.
4. Limited water supply during the dry seasons.
5. Liability of damage to the works from sudden floods. It is believed that this contingency is well guarded against, but the liability of sudden and heavy floods, in a hilly country subject to torrential rains, cannot be overlooked.
6. Excessive rains, liable to wash away embankments, etc., while in the process of construction, and to interfere generally with the progress of the work.
7. The shortness and uncertainty of the yearly periods well suited to the work of construction.
8. Undeveloped state of the country, and scarcity of native labor.
9. Remoteness from the great commercial centers of the world.

In Plate No. 6 are given the proposed cross-sections for the canal by this route. Figs. 1 and 2 show earth cuttings; fig. 3, rock cutting; figs. 4 and 5, tunnel sections.

(TO BE CONTINUED.)

PRESERVING WOODEN PILES.

(Paper read before the Tacoma Society of Civil Engineers & Architects by Mr. Colin McIntosh.)

THE problem of protecting piling and timber in submarine structures against the ravages of the teredo and other marine insects has long been a vexed one, and numerous plans and experiments have been tried, a great many of which with only partial success. Before speaking of these experiments and plans, a description of the pests will not here be amiss. The following is a description of the teredo and its habits: The ship worm—*teredo navalis*—is a mollusk belonging to the tubiferous bivalves, and has been from time immemorial the subject of comment on account of its ravages. There are 24 species of the teredo, but the ship worm is the best known. The *teredo navalis* has a long and flexible body terminating in cutting shells or bits, and is enclosed, for the sake of its protection, in a hose-like shell which reaches from the inferior extremity to within a very short distance of what is known as the head. At that point the muscles come into play and work the cutters or bit edges and so drive into the timber, cutting a smooth, round hole. The teredo first appears in the egg, which is round like a mustard-seed and so small that a hundred of them could be enclosed by the shell of such seed. These eggs are laid at the beginning of the warm season and are deposited from time to time until cold weather sets in. A teredo will deposit from 1,000,000 to 3,000,000 eggs. The eggs hatch in the water and give out minute worms about 0.04 in. in length. They swim about for a short time in search of timber. They enter this by boring or cutting with their cutters, and the entrance is so small that it can be scarcely seen. The worm grows at the rate of 2 in. per month, and digs a hole to accommodate its increasing size. The length of the hole is therefore a guide to the length of the teredo, for it attaches its smaller end to the entrance of its burrow and pushes forward with the growth of its body. As it progresses it deposits a coating of lime upon the sides of its cell, the deposit growing thinner as the worm advances, being quite thick at the entrance.

The worm continues its progress for 12 or 18 months, propagates and dies. It reaches a length of about 10 in., although I have seen one 18¾ in. long, $\frac{1}{16}$ in. diameter of bits. It is remarkable with what accuracy the teredo avoids the burrow of its neighbor, coming within the thickness of a piece of tissue paper. As fine sawdust is found in the stomach of the teredo, it is natural to suppose that it subsists on the same.

It is known that the teredo cannot exist in muddy water, as piling from the Mississippi Sound has been examined after the annual floods, when the river water is very muddy, as the dead bodies of the worm have been found in these piles. Again, it is proven that they can exist for a short time in fresh water, as at Brisbane, Australia, it is forced to survive the annual recurring exposure to fresh water from the floods lasting from two to three months. The limnoria, a brother in mischief to the teredo, is a crustacea about the size of a grain of rice and of a darkish gray color. The front outline of the body is a long oval, though the head is large, round, and strongly defined. The general appearance is that of a wood louse. When disturbed or handled they roll up like a hedgehog. In San Francisco Bay these little creatures are very destructive to piling or timber in submarine structures.

They attack a pile about half-tide and swarm around in millions. They excavate little cells along the annular rings of growth, and while eating the wood for its albumen, make a sheltering place for protection against enemies and a place in which to breed. A pile that has been eaten off by limnoria resembles a piece of wood that has been beavered, except where knots appear; these the insect does not touch.

The plans adopted for protecting piles against these pests are numerous, the best known and most efficient being to creosote them, which is done by subjecting the pile, after being peeled, to two hours' steaming, 10 hours in a vacuum and 12 hours in a retort, in which the creosote is forced into the wood, taking the place of the sap, which has been withdrawn from the wood. From 10 to 12 lbs. of creosote to the cubic foot of wood is about the right charge. This is known to be effective against the ravages of the teredo. The only objection to this process is its first cost. It will not pay to creosote piles on this coast, owing to the low price of same compared with creosote. A creosoted pile, say 40 ft. in length, is worth on the Pacific Coast about $20. Covering piles with copper has been tried and with great success, but as it costs about the same as creosoting it is objectionable on that account.

Studding the exposed parts of the pile with copper tacks has been tried by the New York Harbor Commissioners with success, but as this method uses as much copper as the former and more labor is necessary to put it on, the objection is the same.

Mr. John Culver, an engineer of San Francisco, invented a process consisting of treating the pile in the following manner: First brush a poisonous composition over the peeled pile, which is allowed to dry; next coat the pile with asphaltum laid on at a great heat, after which canvas treated in asphaltum is wrapped around in spiral courses and fastened by copper wire, then another coat of asphaltum and the pile is ready for driving. This process costs about $5 for an average length pile, and has resisted the attack of the teredo in New York Harbor for a period of three years, being the time exposed. The latest plan that has been tried on the Pacific Coast is a covering or coating of Ventura asphalt, which is found in Ventura County, Cal. The piles are peeled, then coated with one or two coats of Ventura asphalt, each coat about ⅝ in. thick. The cost of preparing piles in this manner is about 24 cents per lineal foot. Piles thus prepared have been driven in San Francisco Bay and have been exposed to the attack of the limnoria and teredo for more than a year without any signs of destruction.

The plan adopted by the Northern Pacific Railroad for protecting the foundation of their coal bunker in Tacoma is worthy of mention. This plan consists of driving clusters of piles and encasing the same with wrought iron cylinders of metal ¼ in. thick, and filling in space between piles and cylinder with concrete. The writer believes that sand well packed in the cylinder would answer as well as concrete, for if the iron is eaten away by rust, the concrete is not of sufficient thickness to stand by itself and would readily fall away from the piles. This plan is very efficient.

Another plan tried by the Northern Pacific Railroad similar in design to the above, is in substituting wooden boxes in place of iron cylinders around each pile. This plan was not very effective, as the wood casing was soon eaten away and the concrete fell away from the piles; moreover, it can only be used where the piles are exposed between tides.

The writer tested a covering for piles prepared in the following manner: A section of peeled pile about 3 ft. long was coated with asphaltum and then rolled in sharp sand, and then another thin coat of asphaltum applied. This sample was exposed for a period of 14 months without any signs of destruction, but it was noticed that the asphaltum and sand covering commenced to peel off, leaving the wood exposed, therefore it was abandoned.

Another plan devised by the writer and Mr. Hopkins seems to be plausible, but has not been tried. This consists of slabbing the pile and then tacking on tarred paper on the core, then covering the tarred paper with the same slabs well spiked on. The slabs are not cut full length of the pile, but leave the end that enters the ground solid. The end that is struck by the hammer is to have the slabs removed for a length of 5 ft. or 6 ft., leaving a solid core to receive the blows and to allow for brooming.

In the discussion on this paper the opinion was expressed that the cost of coating a pile with Ventura asphalt had been placed too high, and that it would probably not exceed 12 cents per foot for piles of average size, in Washington or Oregon.

Inquiry was made regarding the old Dutch plan of closely driving long nails into the timber below water-line. The method was not indorsed by those present.

Wrapping the piles with tarred canvas or tarred paper and slabbing them was generally recognized as a cheap method and practicable. Sections of piles thus treated, which had been under water seven and eight years at San Francisco, were submitted. There were but two or three holes made by the teredo through either section.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C.E.

(*Continued from page* 219)

CHAPTER XXV.

HOWE TRUSS DECK BRIDGES (*Continued*).

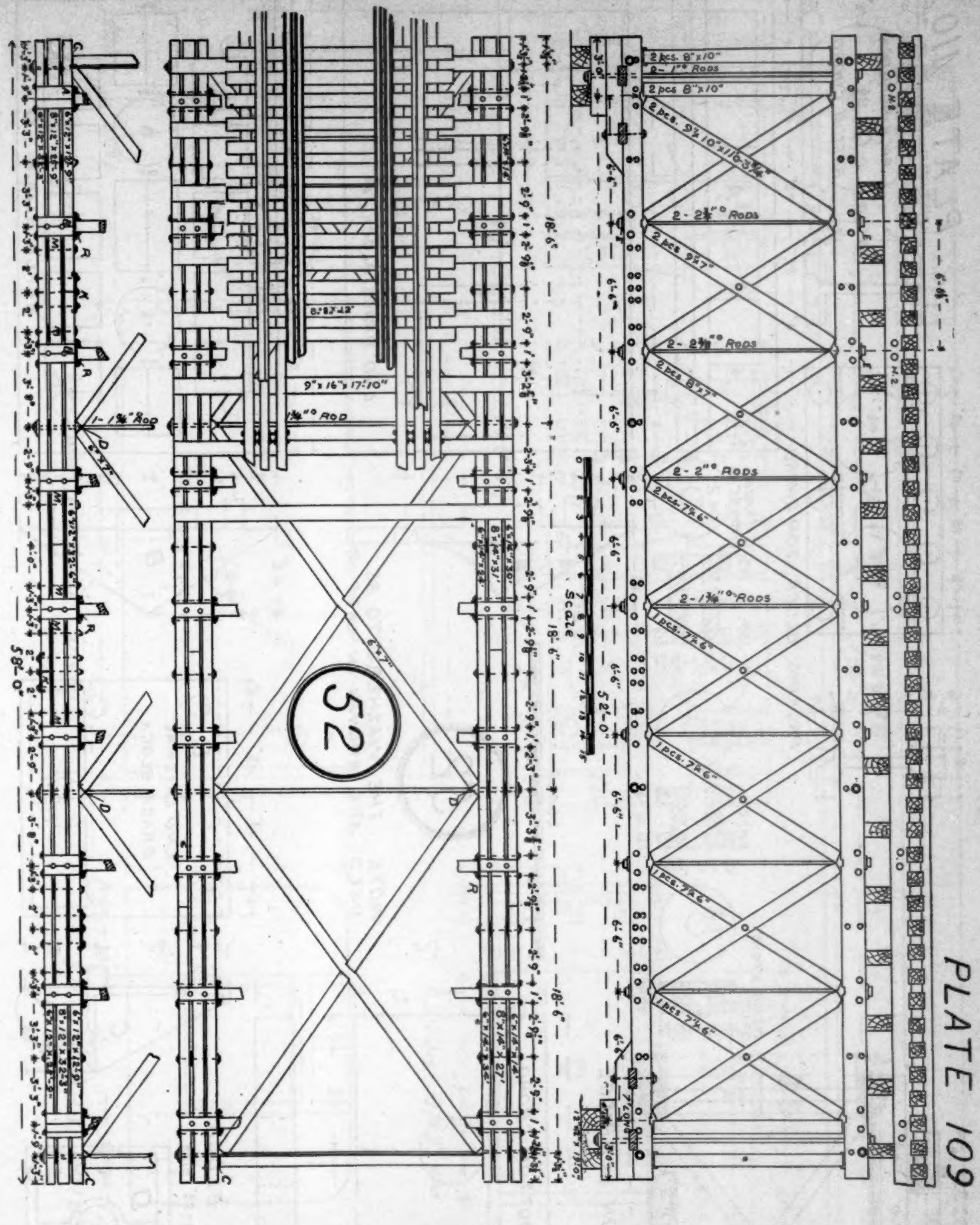
With the preceding chapter there were given plans for a bridge of 42 ft. span. With this chapter the plans are for a Howe truss deck bridge of 52 ft. span; Plate 109 giving an elevation and plans, while the details are shown on a larger scale in Plates 110 and 111.

As with the preceding plans, the construction and details of the bridge are shown very completely by the drawings and the accompanying bill of material, so that little

No. 45. Bill of Material for Howe Truss Deck Bridge, 52 Ft. Span. Plates 109, 110 and 111.

Timber.

No. of Pieces.	Description.	Size.	Length.
4	Top Chord.	6 in. × 14 in.	14 ft. 0 in.
2	" "	6 in. × 14 in.	30 ft. 0 in.
2	" "	6 in. × 14 in.	24 ft. 0 in.
2	" "	6 in. × 14 in.	34 ft. 0 in.
2	" "	8 in. × 14 in.	31 ft. 0 in.
2	" "	8 in. × 14 in.	27 ft. 0 in.
4	Bottom Chord.....	6 in. × 12 in.	12 ft. 9 in.
2	" "	6 in. × 12 in.	32 ft. 6 in.
2	" "	6 in. × 12 in.	32 ft. 3 in.
2	" "	6 in. × 12 in.	25 ft. 9 in.
2	" "	8 in. × 12 in.	25 ft. 9 in.
2	" "	8 in. × 12 in.	32 ft. 3 in.
8	Main Braces........	9 in. × 10 in.	11 ft. 3¾ in.
8	" "	9 in. × 7 in.	11 ft. 3¾ in.
8	" "	8 in. × 7 in.	11 ft. 3⅝ in.
8	" "	7 in. × 6 in.	11 ft. 3⅝ in.
16	Counters............	7 in. × 6 in.	11 ft. 3⅝ in.
16	End Posts..........	8 in. × 10 in.	9 ft. 10½ in.
12	Laterals.	6 in. × 7 in.	22 ft. 6⅝ in.
4	"	6 in. × 7 in.	13 ft. 10½ in.
18	Internal.............	6 in. × 7 in.	17 ft. 3 in.
8	Bolsters.............	6 in. × 7 in.	7 ft. 0 in.
4	"	8 in. × 10 in.	7 ft. 0 in.
8	Bridge-seat.........	6 in. × 10 in.	4 ft. 0 in.
4	" "	8 in. × 10 in.	4 ft. 0 in.
4	Sills.................	12 in. × 12 in.	18 ft. 0 in.
18	Floor-beams...	9 in. × 16 in.	17 ft. 10 in.
6	Track Stringers	6 in. × 12 in.	58 ft. 0 in.
51	Ties..................	8 in. × 8 in.	12 ft. 0 in.
2	Guards.	6 in. × 6 in.	58 ft. 0 in.
4	Plank................	2 in. × 8 in.	58 ft. 0 in.
8	Blocks	2 in. × 8 in.	2 ft. 0 in.



Wrought-Iron—Rods and Bolts.

No.	Description.	Diameter.	Length.	No.	Description.	Diameter.	Length.
8	Rods.	1 in.	14 ft. 6 in.	84	Int'l& splice	⅝ in.	2 ft. 0 in.
8	"	2¾ in.	12 ft. 10 in.	20	Stringerb'lts	⅝ in.	2 ft. 6 in.
8	"	2⅜ in.	12 ft. 10 in.	12	Bolster-b'lts	1⅛ in.	2 ft. 6 in.
8	"	2 in.	12 ft. 10 in.	72	Floor-bolts.	1⅛ in.	3 ft. 0 in.
4	"	1¾ in.	12 ft. 10 in.	36	Tr. str'r b'ts	⅜ in.	2 ft. 10 in.
8	Laterals.	1¾ in.	18 ft. 6 in.	34	Tie-bolts.	¾ in.	2 ft. 6 in.
48	Chord-bolts.	¾ in.	2 ft. 0¼ in.	18	Guard-bolts.	¾ in.	1 ft. 3 in.
16	Brace-bolts.	¾ in.	2 ft. 0¼ in.	32	Spikes.	⅜ in.	....

Castings.

Number: 8 of pattern *A*; 28 of *B*; 8 of *C*; 8 of *D*; 36 of *E*; 40 of *F*; 36 of *G*; 24 of *H3*; 40 of *H2*; 16 of *J4*; 600 of *J1*; 168 of *J2*; 3 of *K*; 10 of *L*; 10 of *M*; 5 of *P*; 36 of *R*; 8 of *S*.

or no further description is required. Some remarks on this design, however, will be made in later chapters.

In comparing these plans, the reader will perhaps find it convenient to refer back to the general remarks on Howe truss bridges given in Chapter XXII., in the JOURNAL for March, 1890.

(TO BE CONTINUED.)

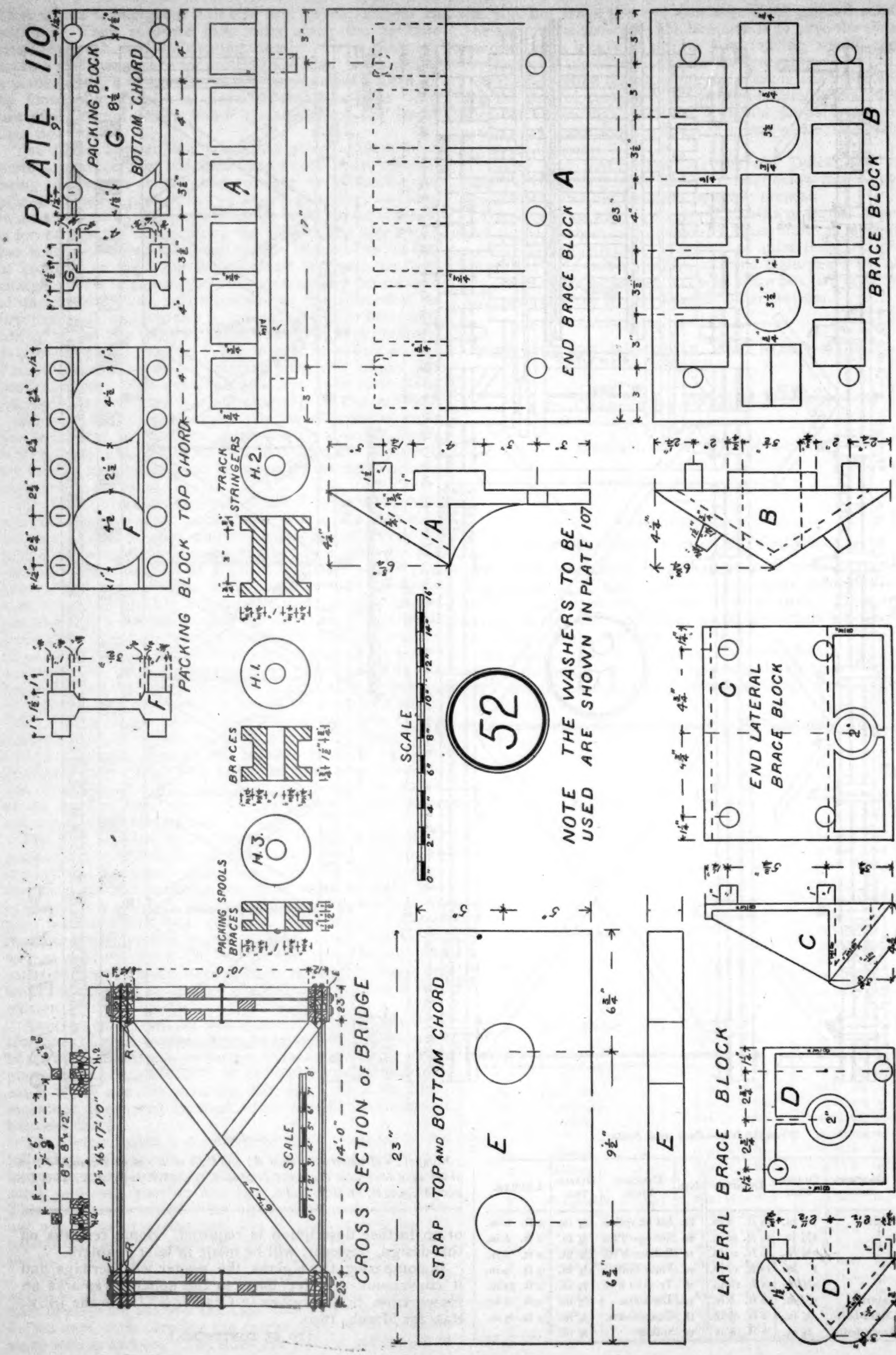


PLATE 110
PACKING BLOCK G BOTTOM CHORD
PACKING BLOCK TOP CHORD
F
TRACK STRINGERS
H.2.
BRACES
H.1.
PACKING SPOOLS BRACES
H.3.
CROSS SECTION OF BRIDGE
SCALE
14'-0"
END BRACE BLOCK A
BRACE BLOCK B
NOTE THE WASHERS TO BE USED ARE SHOWN IN PLATE 107
52
END LATERAL BRACE BLOCK
C
STRAP TOP AND BOTTOM CHORD
E
LATERAL BRACE BLOCK
D

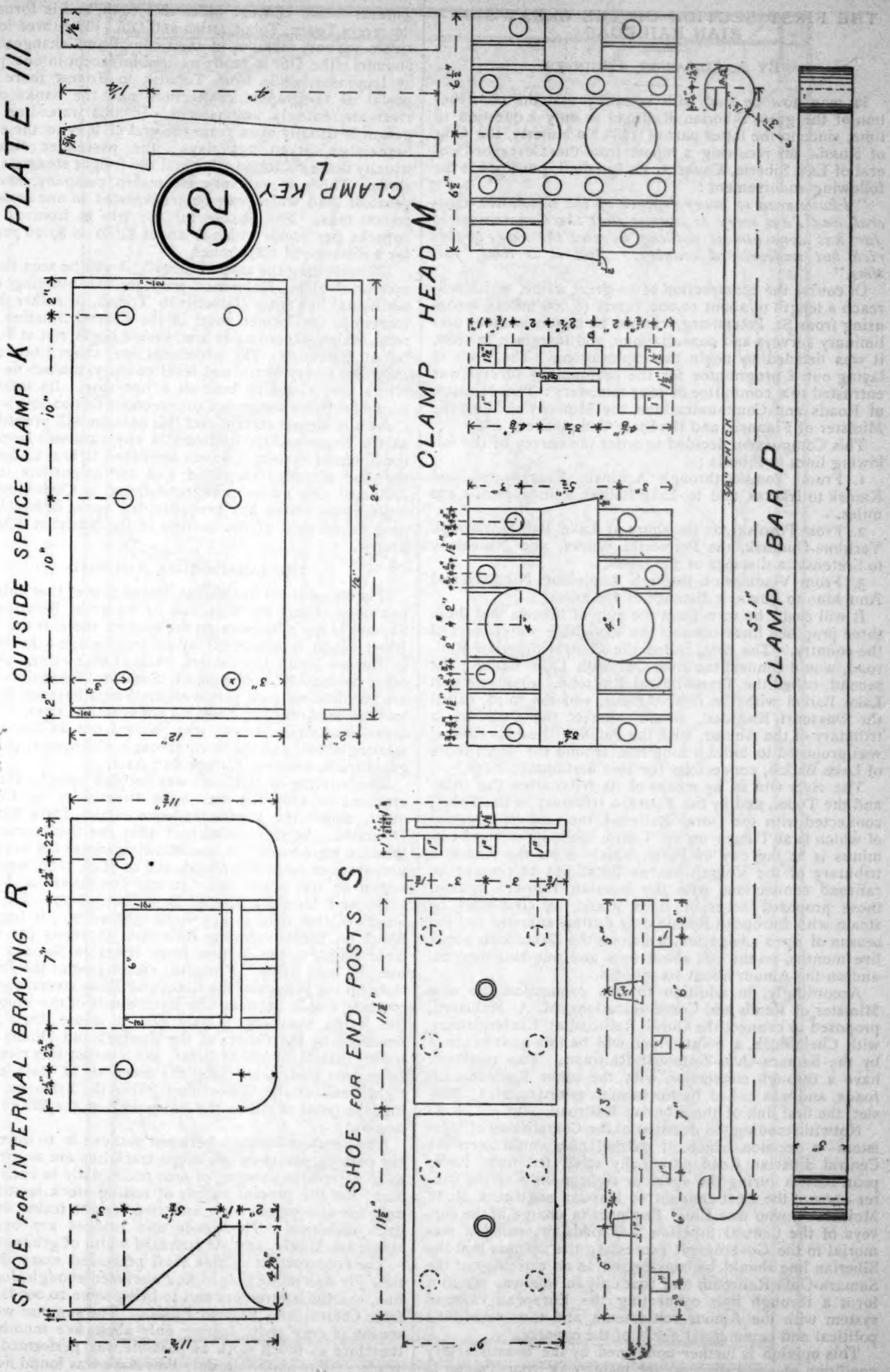


PLATE III
OUTSIDE SPLICE CLAMP K
CLAMP KEY L
52
CLAMP HEAD M
CLAMP BAR P
SHOE FOR INTERNAL BRACING R
SHOE FOR END POSTS S

THE FIRST SECTION OF THE GREAT SIBERIAN RAILROAD.

BY A. ZDZIARSKI, ENGINEER.

IT may now be said with certainty that the construction of the great Siberian Railroad is only a question of time, since in the latter part of 1886 his Majesty, the Czar of Russia, on receiving a report from the Governor-General of East Siberia, Count A. G. Ignatieff, put upon it the following endorsement:

"*I have read so many reports of the Governors-General, and I am sorry to confess that the Government so far has done almost nothing to meet the needs of this rich but undeveloped country. And it is time, full time.*"

Of course the construction of so great a line, which will reach a length of about 10,000 versts (6,666 miles), measuring from St. Petersburg, cannot be begun without preliminary surveys and consultations, and therefore, in 1887, it was decided to begin the explorations. The work of laying out a programme for the preliminary surveys was entrusted to a committee of four ministers: The Minister of Roads and Communications, the Minister of War, the Minister of Finance, and the State Comptroller.

This Commission decided to order the survey of the following lines in Siberia:

1. From Tomsk through Achinsk, Krasnoyarsk and Kainsk to Irkutsk and to Lake Baikal, a distance of 1,130 miles.
2. From Posolski, on the shore of Lake Baikal, through Verkhne-Oudinsk, the Petrowski Works, and Nerchinsk to Sretensk, a distance of 730 miles.
3. From Vladivostok through Razdolnoe, Nikolske and Anuchino to Busse, a distance of 270 miles.

It will easily be seen from the map of Siberia that these three proposed lines connect the navigable water-ways of the country. The first, called the Central Siberian Railroad, would connect the river Obi with Lake Baikal; the second, called the Trans-Baikal Railroad, would connect Lake Baikal with the river Amour, and the third, called the Oussouri Railroad, would connect the Oussouri, a tributary of the Amour, with the Pacific. Besides these it was proposed to build a loop line around the south shore of Lake Baikal, connecting the two first-named lines.

The river Obi is, by means of its tributaries, the Irtish and the Tobol, and by the Toura, a tributary of the Tobol, connected with the Oural Railroad, the eastern terminus of which is at Tumen on the Toura, while its western terminus is at the city of Perm, which is on the Kama, a tributary of the Volga; but as Perm has at present no railroad connections with the Russian railroad system, these proposed Siberian lines would be connected by steam with European Russia only during summer and the season of open navigation, which on the Kama lasts about five months, on the Obi about four and one-half months, and on the Amour about six months.

Accordingly, in addition to this connection, the new Minister of Roads and Communications, M. A. Hubenett, proposed to connect the Oural Railroad at Ekaterinbourg with Chelabinsk, a point which will be this year reached by the Samara-Oufa-Zlatooust Railroad. This road will have a through connection with the other Russian railroads, and was called by the former minister, M. C. Possiet, the first link of the Siberian Railroad.

Notwithstanding the decision of the Commission of Ministers—a decision which, if carried out, would keep the Central Siberian Road practically separated from European Russia during the seven or eight months of the winter—one of the most eminent of Russian engineers, N. P. Mejeninov, who was Chief Engineer in charge of the surveys of the Central Siberian Railroad, presented a memorial to the Government expressing the opinion that the Siberian line should be constructed as an extension of the Samara-Oufa Railroad, and that only in this way would it form a through line connecting the European railroad system with the Amour settlements, and thus satisfy the political and commercial needs of the country.

This opinion is further confirmed by the unsatisfactory condition of navigation on the water-way from Tumen to Tomsk, which is 1,870 miles in length, and is formed of the rivers Toura, Tobol, Irtish and Obi. The three former rivers are very tortuous in their course and changeable in channel; the Obi is easily navigable except in one place, at Laminsor, while from Tobolsk to Tomsk there is no postal or telegraphic connection, and the banks of the river are entirely uninhabited. In this water-line navigation is usually open from the end of May to the end of September, about 135 days; the passenger steamers usually make six round trips and the freight steamers only three. There is only one steamship company, and the greatest load which can be transported in one season is 60,000 tons. The charge for the trip is from 15 to 25 copecks per poud, which is about $4.80 to $7.20 per ton, for a distance of 1,870 miles.

By consulting the map of Siberia, it will be seen that the memorial of M. Mejeninov proposes the building of an additional line from Zlatooust to Tomsk, or rather the extension to the former point of the Central Siberian Railroad, which, according to him, should begin, not at Tomsk, but at Zlatooust. The additional line, about 1,000 miles, traverses a very fertile and level country, crosses no great rivers, and could be built at a low rate. Its total cost would probably not exceed 50,000,000 to 60,000,000 roubles.

As it is almost certain that this opinion will prevail, and as the Samara-Oufa Railroad in any case will be part of the Siberian system, I have considered it best to describe the line already completed and the extensions toward Zlatoonst now under construction, and to Chelabinsk, the building of which has been decided upon, before beginning an account of the surveys of the Siberian Railroad proper.

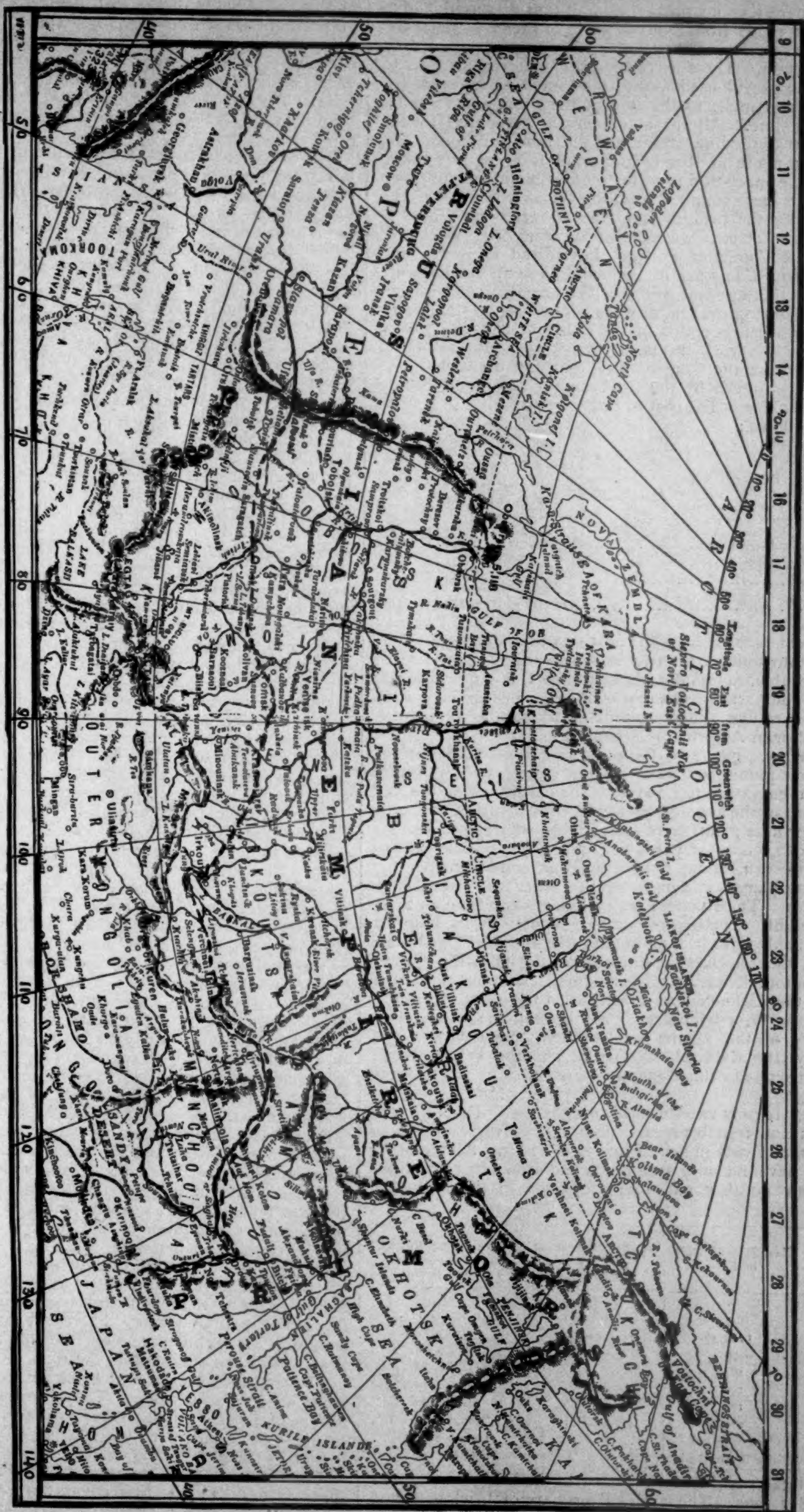
THE SAMARA-OUFA RAILROAD.

It is not without reason, as stated above, that this road has been called the first link of the great Siberian line. Samara is the only town on the eastern shore of the Volga River which is connected by an iron bridge—the longest in Europe—with the eastern bank of that river. All the other towns—Nijni-Novgorod, Saratov, Tsaritsin—which are terminal railroad points on the Volga have no bridges, and the lines reaching them do not cross the river. Under these conditions Samara was pointed out as the proper starting-point, and the town through which must pass the great traffic between Europe and Asia.

The building of this road was decided upon by the Government in 1885. It was built directly by the Government, under the superintendence of the State Railroad Direction. In the summer of 1885 the final survey and location were made; in the following winter the necessary preparations were completed, and in May, 1886, work was begun on the whole line. It was completed in August, 1888, and formally opened September 8–20 The total length of this road is 453 versts (302 miles); it begins at Kinel on the Orenbourg Railroad, 38 versts (25 miles) from Samara, the section from Kinel to Samara being used by both roads. From the starting-point the line follows up the valleys of the Kinel and Kista rivers, then rise over the divide between the water-sheds of the Volga and the Kama, reaching a level 980 ft. above Oufa; then descends by the valleys of the Koursak and Dioma rivers to the Bielaia or White River, and crosses this river on a large iron bridge, reaching the terminus at Oufa, on the right bank of the White River, near the Sofronov Landing, the point at which the navigation of the White River begins.

The greatest distance between stations is 16 miles, and the passing places on the single-track line are so arranged as to permit the running of nine trains daily in each direction; but the present supply of rolling stock is sufficient only for one mixed train and two freight trains daily in each direction. The grade and bridges are built for single-track only, and the standard width of grade is 18 ft.

The construction of this road presented many difficulties. It was impossible to find workmen enough along the line, and the contractors had to bring some 20,000 laborers from Central and Eastern Russia. The summer working season is very short, lasting only about five months, and therefore as much work as possible was performed in the winter. For materials, only limestone was found near the



SIBERIA AND THE GREAT SIBERIAN RAILROAD.

NOTE.—The heavy black line from Samara to Chelabinsk shows the section completed or under construction; the dotted line from Chelabinsk eastward shows the proposed line of the road as described.

line. There was no timber, and all that was used had to be carried either from Samara, Oufa or Sterlitamak, a distance of 140 miles, so that the supply of ties was very difficult to obtain. There was little or no material for ballast, so that the gravel used had to be hauled an average distance of two miles to the line of the road, and 12 miles along the line. All the machinery and supplies for the equipment of the line, water stations, tools for workshops, etc., were made in Russia and from Russian raw materials. The sheet-iron used for roofing buildings and most of the rails were supplied from the Oural Iron Works, and the iron for the bridges from the Government Works at Votkinsk. Cement was obtained from the works of Schmidt & Company in Riga, Port-Kund in Revel, and the Moscow Company in Podolsk. The materials were carried to the terminal points of the line by water in summer, and during the winter were hauled out on the line by teams, with the exception of the rails and ties which were carried by the work trains. All the work was sub-let to contractors on the basis of price per unit of work. The work done directly by the Government amounted to only 584 000 roubles. The cost of this line, 302 miles in length, was as follows:

Part of Work.	Cost in Roubles.		Per Cent. of Total.
	Total.	Per Mile.	
Grading and substructure	17,082,932	56,566	71.7
Rails and fastenings	3,663,628	12,131	15.4
Rolling stock	3,075,178	10,183	12.9
Total	23,821,738	78,880	100.0

The cost here is given in roubles, and they are not converted into dollars for two reasons: the exchange price of the rouble, nominally about 50 cents, is very variable, and the comparative cheapness of labor in Russia is such that for a rouble almost as much work can be obtained as for a dollar in America by a contractor.

The highest grade on the road going eastward is 1 per cent., and going westward 0.8 per cent. The minimum radius of curvature is 1,400 ft. The earthwork on the line was not easy, the average quantity moved being 53,640 cubic yards per mile; but there were miles where the quantity rose to 950,000 cubic yards per mile. The greater part of the earthwork, about four-fifths, was embankments, the line being placed at a high level in order to prevent snow blockades. The smallest embankments are from 2½ to 3½ ft. in height. The highest embankment is 70 ft., and is a dam or bank 3,640 ft. long in the valley of the White River.

From Kinel to Oufa the line crosses the following rivers: the Koutouluk and the Kourtamak, tributaries of the Kinel; the Little Kinel; the Kinel, a tributary of the Samara; the Ik, a tributary of the Kama; the Kaursak, a tributary of the Dioma; the Tulen, the Oudriak, the Balashly, the Kalmash, the Ouza, and the White River. The last-named bridge has six spans, each of 350 ft. clear opening.

There are only two kinds of bridges used, masonry arch culverts and iron bridges. The arch culverts are 80 in number, and vary in span from 3½ to 17½ ft. All the other bridges have masonry abutments and iron superstructure, and their number and size are given in the following table:

No. of Bridges.	Clear Span of Bridge in Feet.	Weight of Superstructure of One Bridge.	
		Deck Bridge.	Through Bridge.
110	7	1,908 lbs.	....
97	14 to 56	....	....
2	70	48,000 lbs.	76,900 lbs.
1	105	....	137,600 lbs.
3	140	203,800 lbs.	242,100 lbs.
3	175	332,500 lbs.	334,000 lbs.
2	210	499,300 lbs.	489,200 lbs.
1	350 (6 spans) White River Bridge	....	1,262,600 lbs. (1 span).

The total weight of iron used in the bridge structures was 5,847 tons. The arch culverts are of brick or stone, and the abutments of the iron bridges of limestone. As good stone was scarce, at many points it had to be carried 80 miles from the quarries to the point where it was needed. The sandstone for the ice breakers of the piers of the White River bridge was floated 200 miles down the river. The abutments of the small bridges up to 14 ft. span have a common foundation, and the masonry is all of good class.

The most conspicuous structure on the line is the White River bridge. The piers and abutments are founded on caissons sunk by pneumatic process. The foundation for the piers is 56 ft. below the low-water level, and the foundations of the abutments are respectively 42 and 49 ft. below low-water level. The masonry is of limestone, which was brought 100 miles down the Oufa River. This stone has an ultimate resistance of 8,750 tons per square inch to crushing. The up-stream faces of the piers and the ice-breakers were of sandstone brought 200 miles down the river from the Oural Mountains. This sandstone has double the strength of the limestone, its ultimate resistance being 17,500 lbs. per square inch. The superstructure of this bridge was designed by Professor N. A. Beleloubski, and is a through truss of semi-parabolic system with double intersections, somewhat resembling the Linville truss. The chords are of channel shape. The posts are made of four or more separate angle-bars placed at such a distance apart that the floor-beams could be fixed between them. The chief feature of this bridge is that the floor-beams are not riveted to the lower chord, but are carried on special hinges or links, so that the strain from the floor-beams is transmitted to the center of the chord, avoiding all torsional strains of the channel-bars, and therefore the strain on the lower chord is much less. This system of hanging the floor-beams requires separate cross-girders to connect the lower chords.

The ballast used on the road is sand and gravel, principally sand. It is laid 15 in. thick under the rail, and the general width of the ballasted road-bed is 10½ ft.

The ties are of pine and spruce, and are generally of semicircular section, split from logs 10½ in. in diameter. There are also some ties 8½ × 6 in. in section. Their length is everywhere 8 ft., and they are spaced 2½ ft. apart, so that 2,160 ties to the mile were used.

The rails are of steel and are of two types, the first 67½ Russian pounds (61½ English pounds) to the yard, and the second 72 Russian pounds (66 English pounds) to the yard. The rails are 24 ft. long, and each has a bearing upon 10 ties. The joints are angle splices with two underplates fixed by means of bolts and spikes, and are placed between the ties. The rails are, as usual in Europe, inclined slightly toward the axis of the track. The gauge of the road is the standard Russian gauge of 5 ft.

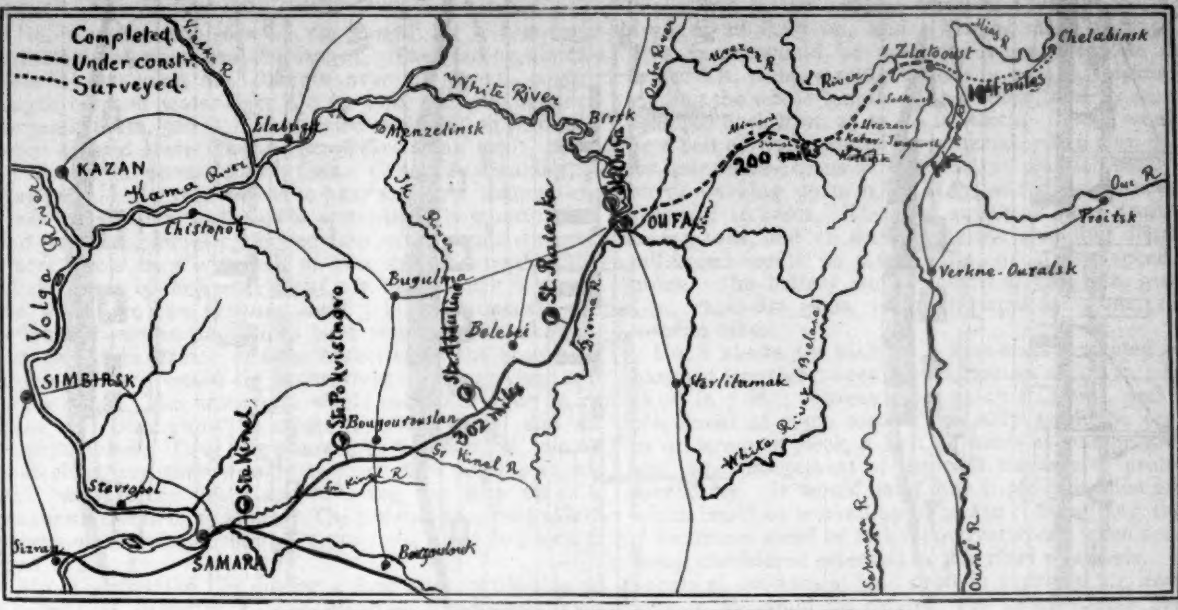
The buildings would be considered numerous and luxurious on an ordinary American road. Under the system of protecting the track, at every two miles and near each crossing there is a watchman employed; on each section is a roadmaster with a suitable gang of trackmen. For the accommodation of these men there are 233 watchmen's houses and 47 section-houses, 25 of the latter being at stations and the remaining 22 at points between stations. All of these buildings are of wood placed on masonry foundations. There are 267 road crossings, and almost every one is protected by a gate and watchman.

The station buildings are of the standard Government railroad type and are 25 in number, two of them being of the second class, three of the third class, and 20 of the fourth class. No first-class buildings were put up, as, according to the regulations, such buildings must be provided with luxurious and costly apartments for the use of the Emperor. Of these stations and buildings, 23 are of brick and two of stone. There are only four separate freight stations, but others will be built as their necessity is shown by the operation of the road.

The engine-houses are of brick or stone, with wooden roofs covered with paper. They have wooden floors and are heated with round stoves. There are five of these engine-houses, all of rectangular form, and having altogether 43 stalls.

The repair shops of the road are at Oufa, and consist of three buildings: the first covers an erecting and paint

shop, 133 × 126 ft.; a machine shop, 161 × 56 ft.; a wheel and spring shop, 59 × 56 ft.; a smith shop, 72 × 56 ft.; a brass foundry, 28 × 56 ft.; an engine-room, 31½ × 21 ft., and a boiler-room, 42 × 35 ft. The second building covers two car-repair shops each 119 × 45½ ft. and a paint shop 70 × 119 ft., while the third and smallest building includes a wood-working shop 52½ × 70 ft. There is also a small separate smith shop for car work, 24½ × 16 ft. in size. All the buildings are of masonry with sheet-iron roofs, but the smith shop and foundry are roofed with corrugated galvanized iron. The roof trusses in the largest building are of iron; in the other departments they are of wood. Besides these shops there are three small shops at other points on the line, for making ordinary running repairs.



MAP OF THE SAMARA-OUFA-ZLATOOUST RAILROAD.

According to the Russian system of operating the railroads, the Government provides lodgings for all the officers and employés. This has required the building of 86 houses of various sizes, all of wood on masonry foundations, and placed at various stations along the line. The country is very thinly inhabited, and more houses are now found to be necessary.

A water supply is necessary at each of the 23 stations, and the arrangements are uniform in character. At each of these there are iron tanks protected by wooden covering, and placed on masonry piers. The tanks are generally of 2,744 cubic feet capacity, with the bottom elevated about 28 ft. above the level of the rails. They are placed usually about 100 ft. from the main track, and for filling the tenders hydraulic cranes are placed close to the track. At one station the tank is supplied from a high level by means of gravity, but at the other 22 pumping engines are required, which vary from 4 to 10 H. P.

The stations are fully equipped with signals and switches, and for this purpose there were used 259 ordinary switches, 2 triple switches, 49 iron semaphores, 49 green signal disks at stations, 110 stop-blocks, and 60 switch-houses. There are five turn-tables of the Sellers pattern, 55 ft. in diameter. The station yards are paved, and are provided with gardens and fences.

The rolling stock is of the European type and without trucks. There are on the road 31 six-wheeled engines weighing 32 tons each without fuel or water; 29 eight-wheeled freight engines weighing 42 tons each. The passenger rolling stock consists of one officer's car; six cars with first and second-class compartments; eight second-class cars; 12 third-class cars; five combination third-class and postal cars, and four special cars for the transportation of exiles. The freight equipment consists of 640 box-cars and 160 open or flat cars. The capacity of a Russian freight car is usually 21,000 lbs., and the weight of a box-car about 14,000 lbs.

As to the cost of the road, it will not be without interest to give a detailed statement of the distribution of the cost of the works on this road, which, as before stated, is 302 miles in length, and such a statement is given in the following table:

	Description of Work.	Cost in Roubles. Total.	Per Mile.	Per Cent. of Total.
1	Expropriation, lands, etc	316,262	1,047	1.3
2	Earthwork	4,355,464	14,422	18.2
3	Bridges	5,010,894	16,592	21.0
4	Track	5,585,379	18,495	23.4
5	Road accessories	84,991	281	0.4
6	Telegraph line	118,151	391	0.5
7	Road buildings and gates	493 337	1,632	2.1
8	Station buildings	1,591,079	5,268	6.7
9	Water supply	443,689	1,469	1.9
10	Station accessories	475,688	1,575	2.0
11	Rolling stock	3,519,928	11,655	14.8
12	Road and landing in Oufa	54,867	182	0.2
13	General expenses	1,349,692	4,469	5.7
14	Extraordinary expenses	104,769	347	0.4
15	Comptrolling and police	111,234	368	0.5
16	Sundries	192,855	639	0.8
17	Loss on material and property	13,459	45	0.1
	Total	23,821,738	78,877	100.0

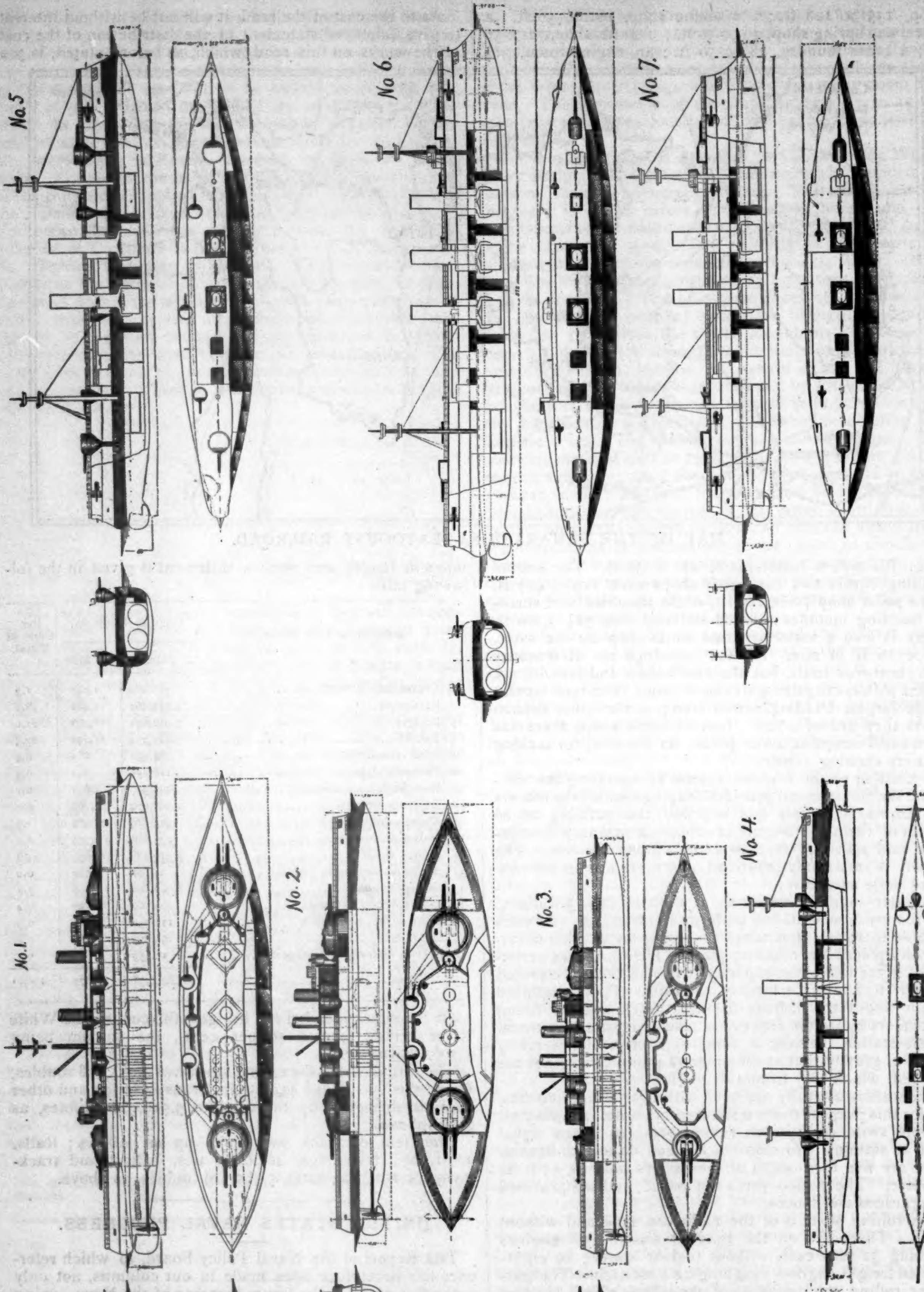
Of the sum expended for bridges, the cost of the White River bridge formed 46 per cent., the amount being 2,306,075 roubles.

The actual cost of the rolling stock was 3,075,178 roubles, but to this was added 444,750 for transportation and other charges, bringing up the total to 3,519,928 roubles, as given above.

The item of track was made up as follows: Rails, 3,181,009; fastenings, 482,618; ties, ballast and track-laying, 1,192,752; total, 5,585,379 roubles, as above.

UNITED STATES NAVAL PROGRESS.

The Report of the Naval Policy Board, to which reference has heretofore been made in our columns, not only outlined a plan for the future increase of the Navy, giving the numbers of each class of ships which would be required to make a naval force appropriate to the position and power of the United States, but presented plans for a number of different classes of ships which should be used. The accompanying sketches present these plans reduced to a small scale, which is sufficient, however, to show their general features, as in such a report as that pre-



DESIGNS FOR WAR-SHIPS SUBMITTED BY THE NAVAL POLICY BOARD.

sented by the Board it was, of course, not necessary or practicable to carry these plans out to minute details. We give below also a description of each class, which is necessarily very brief. The number attached to each sketch corresponds to the number in the text below.

No. 1 is the type plan of the Board for a first-class battle-ship of great coal endurance. The leading dimensions of this plan are: Length over all, 349 ft. 2 in.; length on load water-line, 340 ft. 2 in.; length between perpendiculars, 326 ft. 6 in.; extreme beam, 71 ft. 6 in.; beam on load water-line, 69 ft. 9¾ in.; mean draft, 25 ft. 4½ in.; diplacement, 10,000 tons. Generally speaking, it may be said that this ship is to have a double bottom, engines and boilers in separate water-tight compartments, and the ship, generally, divided into many compartments. There would be a wide belt of 5-in. armor extending the whole length of the vessel about 5 ft. below and 5 ft. above the water-line; an armored deck 3 in. in thickness; the redoubt shown on the plan to have 16-in. armor; the turrets also 16-in. armor, and the barbettes for the guns 3-in. armor. There would be two turrets each carrying two heavy guns. The armament would consist of four 12-in. guns, ten 5-in. guns, 20 small rapid-fire guns, and six torpedo tubes. Four engines would be provided, two on each shaft, and they would be expected to develop 11,000 H.P. with forced draft, and to bring the ship up to a maximum speed of 17 knots. The provision for coal would permit of carrying a total of 1,350 tons, or of 675 tons at load draft.

No. 2 shows the design for a first-class battle-ship of limited coal endurance. The principal dimensions are: Length over all, 314 ft.; length on load water-line, 306 ft.; length between perpendiculars, 296 ft.; extreme beam, 67 ft. 9¼ in.; mean draft, 23 ft. 3 in.; displacement, 8,000 tons. The armor provided for in this design is a belt of 17 in. in thickness, 164 ft. in length, and about 8 ft. in width at the water-line, ending in bulkheads of 14 in. in thickness; an armored deck above this belt and a submerged deck 3 in. thick extending to the ends of the vessel. The redoubts and turrets would have a thickness of 17 in. of armor and the casemate 4 and 5 in., with appropriate protection for the smaller guns. The armament would consist of four 13-in. guns, four 5-in. guns, 12 smaller rapid-fire guns, and six torpedo tubes. Two triple-expansion engines would furnish the power and would be expected to indicate 7,500 H.P. with forced draft, and to drive a vessel at a maximum speed of 15.8 knots. The total coal capacity is given at 500 tons and the normal supply at load draft 300 tons.

The second-class battle-ship would be similar to this in all respects, but would be somewhat shorter, 290 ft. between perpendiculars, and have a displacement of only 7,100 tons and a somewhat lighter battery.

No. 3 shows the third-class battle-ship of limited coal endurance, which is of very similar plan, but the following dimensions: Length between perpendiculars, 280 ft.; extreme beam, 65 ft. 6 in.; mean draft, 21 ft. 6 in.; displacement, 6,000 tons; to have two triple-expansion engines capable of working up to 6,500 H.P. and of giving a speed of 15.8 knots. The armor would be somewhat lighter than that in the first-class ship, including a water-line belt 15 in. thick, 155 ft. long, with bulkheads 13 in. thick; an armored deck 2½ and 2¾ in. thick; redoubts with 15-in. armor; a barbette with 12½ in. and a casemate with 4 in. of armor. The battery would include two 12-in. guns, two 10-in. guns, four 5-in. guns, 16 small rapid-fire guns, and six torpedo tubes.

No. 4 shows a ram for harbor defense carrying only a limited supply of coal, as it is not expected to be used as a cruiser. The general dimensions of this are: Length between perpendiculars, 313 ft.; extreme beam, 42 ft. 1½ in.; mean draft, 18 ft. 2½ in.; displacement, 3,500 tons. On this vessel, for a length of 70 ft. forward, protection would be afforded by side armor of 4 in. worked on heavy Z-frames extending from the armored deck to below the water-line; abaft this bulkhead the protection to be continued by an armored deck with double side slopes. The engines would be of the triple-expansion type, four in number, two on each shaft, capable of working up to 9,700 H.P., and of giving a maximum speed of 20¼ knots with forced draft. The armament would consist of four 5-in. guns, 11 small rapid-fire guns, and two torpedo tubes.

No. 5 gives the type plan for a first-class thin armored cruiser, which would have a length between perpendiculars of 335 ft., an extreme beam of 67 ft. 6½ in., a mean draft of 22 ft. 3 in., and a displacement of 6,250 tons. This vessel would be protected by a complete belt of armor 8 ft. wide, varying from 5 to 4 in. in thickness, extending the whole length of the vessel, and by an arched armored deck from 2½ to 2½ in. thick. There would also be a belt of water-excluding material. The plan provides for four triple-expansion engines, two on each shaft, capable of working up to 9,800 H.P., and giving a maximum speed of 19 knots. The coal supply at load draft would be 625 tons, and on this supply the steaming distance at full speed would be 2,100 miles, or at low speed 7,000 miles. The battery would consist of two 8-in. guns, ten 5-in. rapid-fire guns, 18 small rapid-fire guns, and six torpedo tubes.

No. 6 shows the plan for a first-class protected cruiser having a length between perpendiculars of 372 ft.; a beam of 58 ft. 7 in.; a mean draft of 23 ft. 1½ in., and a displacement of 7,500 tons. This ship would be protected by an armored deck, a belt of water-excluding material, and the arrangement of the coal bunkers to protect the machinery. It would have four triple-expansion engines, which could be worked up to 20,250 H.P., giving the ship a maximum speed of 22 knots, great speed when necessary being considered essential to this class of vessels. A coal supply of 900 tons at load draft is provided for, and 1,600 tons in all could be carried, the latter supply giving a cruising range at low speed of 15,000 miles. The armament would be substantially the same as that of the thin-armored cruiser, consisting of two 8-in. guns, ten 5-in. rapid-fire guns, 18 small rapid-fire guns, and six torpedo tubes.

No. 7 is a plan for a second-class protected cruiser having a length between perpendiculars of 324 ft.; an extreme draft of 53 ft. 6 in.; a mean draft of 20 ft. 7 in., and a displacement of 5,400 tons. This ship also is protected in the same way as the first class cruiser—that is, by an armored deck, a belt of water-excluding material, and the arrangement of the coal bunkers. It would also have four triple-expansion engines, giving 12,000 H.P. with forced draft, and a speed of 20 knots, with a total cruising range at low speed of 11,200 miles. The armament would consist of two 8-in. guns, twelve 5 in. rapid-fire guns, 14 small rapid-fire guns, and six torpedo tubes.

The report also recommends several other classes of vessels, smaller cruisers, gun-boats for special service, torpedo boats, and ships for torpedo depots and for repairs, for which no plans are given.

It is believed that the brief descriptions given above, with the plans, will be sufficient to give a general idea of the vessels recommended by the Board, and we also add below a summary of the general recommendations presented in its report as to the principles which should govern the plans for new vessels.

1. *Hulls* to be of mild steel, all riveting to be by machine, and the limit of tensile strength to be 10 to 20 per cent. greater than now used. As little wood-work as possible to be used.

2. *Armor* to be of steel, on thin backing against heavy plating; protective decks to be carried on heavy beams. Extensive use to be made of woodite as a subsidiary protection; this material to be used for water-line belts and similar purposes. All guns to be protected by shields when not enclosed in barbettes or turrets.

3. *Guns* to be arranged so as to obtain a large proportion of the total fire on all bearings. The heaviest proposed is 13 in., 35 calibers long, weighing about 60 tons; the next 12 in., 35 calibers long, weighing 50 tons. Other types include the 8-in. and 5-in. breech-loading rifles, 5-in. rapid-fire, and two sizes of small rapid-fire guns—6-lbs. and 1 lb.

4. *Engines* to be of the triple-expansion type, using steam of 160 lbs. pressure; for nearly all the ships four engines to be used, two on each shaft. This involves somewhat more space and weight, but better proportioned engines can be obtained, and for cruising at low speeds

only two engines need be used. The boilers proposed are of the cylindrical type; forced draft to be by the closed stoke-hole method.

PROPOSALS FOR A PROTECTED CRUISER.

Proposals will be received at the Navy Department until June 10 for the new protected cruiser. This ship is to be built on the double-bottom cellular system, with numerous water-tight compartments, and will have an armored deck 4¾ in. thick on the slopes and 2 in. thick on the flat over the machinery spaces; 3 in. on the slopes and 2 in. on the flat, fore and aft. A belt of woodite 33 in. thick, in coffer-dams extending 4 ft. above and 4 ft. 5 in. below the load water-line, extends the whole length of the vessel. Coal protection is afforded to the machinery by the location of the bunkers along the side below the protective deck and above the deck for the length of the boiler and engine space. The hull plating is increased in thickness in wake of all machine guns.

The general dimensions are: Length on load water-line, 314 ft.; extreme breadth, 53 ft.; mean draft, 21 ft. 6 in.; displacement, 5,500 tons.

There are to be two screws, each driven by a triple-expansion engine with cylinders 42 in., 59 in., and 92 in. in diameter and 42 in. stroke. There will be six boilers, built to carry 160 lbs. working pressure. These engines are to work up to 13,500 H.P. with forced draft, and to give the ship a maximum speed of 20¼ knots. The total coal supply will be 1,300 tons, which will give a cruising range of 2,200 knots at full speed or 13,000 knots at half speed.

Minor points include steering-gear entirely below the protective deck; a full electric-light system; artificial ventilation by blowers; two steel masts with double fighting tops. The quarters will have provision for 25 officers and 441 men.

The main battery is to consist of two 8-in. and ten 4-in. breech-loading rifled guns. The 8-in. rifles are mounted on the center line in barbette turrets 4 in. thick, one at the forward and one at the after end of the superstructure, and train from directly ahead or astern to 50° on each side, abaft or before the beam, respectively. The ammunition is supplied through armored tubes 3 in. thick, which permit loading in any position. The 4-in. guns are mounted on improved central-pivot mounts, and protected by fixed segmental shields 4 in. thick; four of these guns forward have a fire from direct ahead to 63° abaft the beam; the four after guns have a similar train before the beam; the two 4-in. guns amidships have a broadside train through 146°. The fire of all the forward and after guns respectively can be concentrated upon an object the length of the vessel directly ahead or astern. The secondary battery will consist of eight 6-pdr. and six 3-pdr. rapid-fire guns, and 14 machine guns, mounted to be clear of the smoke and fire of the main battery and for efficient action against boat attacks. Wherever practicable protection is afforded the machine guns by plating 2¼ in. thick. In each of the lower military tops are mounted a 37-mm. Maxim and a 1-pdr. Hotchkiss gun. An allowance of 150 rounds will be provided for each of the 8-in. and 4-in. guns. An average of about 3,600 rounds is allowed for each of the guns in the secondary battery.

The torpedo outfit consists of six launching tubes for Howell automobile torpedoes, one fixed at the stem, one at the stern, and two training tubes on each broadside.

TRIAL TRIPS OF NEW VESSELS.

The preliminary trial of the *Philadelphia* was made by a trip down the Delaware and a short distance out to sea; the results are not reported, as the trial was not an official one, but it is stated that they were very satisfactory to the builders, and that the speed of the ship and her general action under steam were fully equal to expectations.

The torpedo-boat *Cushing* has been sent from the builders' yard at Newport to the Washington Navy Yard. The official trials will take place shortly, and the results are looked for with interest. The *Cushing* showed very good speed on her trip to Washington, although no attempt was made to drive her to full power.

THE DEVELOPMENT OF ARMOR.

BY FIRST LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.

(*Continued from page* 217.)

XII.—THE CONFEDERATE IRON-CLADS.

FROM the beginning, the Confederate naval authorities were far more alive to the necessity of armor-clad vessels than our own. Their construction, however, was attended with difficulties of which we knew nothing. Except the Tredegar Works, at Richmond, there were, at the beginning, no mills capable of rolling armor-plate; there were few or no merchant steamers beyond a river steamboat that could be converted for naval use, and few facilities for building new ones; iron was scarce, and trained seamen hard to get. Later on rolling mills were established at Selma and Atlanta. Notwithstanding these disadvantages, the armored fleet turned out was an exceedingly creditable and serviceable one.

The *Merrimac* or *Virginia*, as they called her, was the first essay in the direction of an iron-clad. As already stated, this vessel was well under way before the keel of the *Monitor* was laid down. The hull of the old frigate *Merrimac* served as a foundation, and upon this a casemate 140 ft. in length was erected, with sides sloping at an angle of 35°. The armor was rolled out of railroad iron into plates 8 in. in width and 2 in. in thickness. Two layers of these iron slabs were secured to the sides and ends of the casemate; the inner layer horizontal, the outer

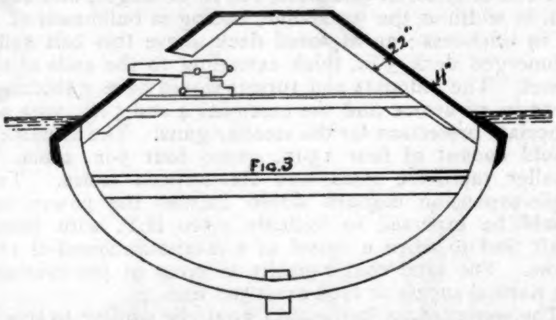


FIG. 3

one vertical. The wood backing was 22 in. in thickness, through which the armor bolts were driven and clinched on the inside. The pilot-house at the forward end of the casemate was conical and armored. Iron gratings covered the top of the casemate. Fig. 3 gives a cross-section, and shows the method of applying the armor. The sides of the casemates were carried 2 ft. below the water-line, and the ends were submerged the same distance. The armor was continued down to the knuckle, where it was clamped. Bulwarks were erected around the submerged ends. The *Merrimac* served, in all essential particulars, as a model upon which all of their subsequent iron-clads were built.

Built for the defense of Mobile, the *Tennessee* may be said to have been the most powerful, if not the most creditable production of the Confederate naval authorities. With the exception of her engines, she was built entirely of home-prepared material. She was a casemated iron-clad much like the *Merrimac* in general design, with a casemate some 80 ft. in length, whose sides and ends sloped at an angle of 45°. Like the *Merrimac*, the casemate was carried 2 ft. below water, and then returned to meet the sides some 7 ft. from the water-line. The knuckle projected 10 ft. beyond the casemate, and afforded ample protection against an enemy's rams. The armor on the sides was 6 in. in thickness, made up of three 2-in. plates 7 in. in width. On the ends the armor was 5 in. in thickness, all secured by through bolts set up with nuts on the inside. Behind the armor was a backing of 25 in. of oak and yellow-pine. Two inches of iron protected the deck, and the ports were closed with 5-in. sliding iron shutters.

The iron-clad ram *Atlanta* is said to have been built with a special view to raising the blockade along the South Atlantic Coast. When finished her constructors evidently believed her to be more than a match for any of the blockading fleet. It was a case of sadly misplaced confidence. The hull of a blockade-runner supplied the foundation upon which a casemate with inclined sides and ends was erected. Upon the 18 in. of pine and oak backing two layers of 2-in. armor-plate, rolled out of railroad iron, were fastened. To obtain the necessary flotation a raft of timber was built over the deck and 6 ft. out from the sides, where it met the slope of the casemate. The armor was secured by through bolts and nuts. A ram and torpedo-spar completed her equipment.

Perhaps no war vessel was ever constructed under greater difficulties than the *Albemarle*. Built in an open cornfield, of unseasoned timber, and with only such aid as was afforded by a common country blacksmith's forge, of which not only the material for the iron plating but much of that for the machinery was literally picked up in bits, wherever it could be found, it was a brilliant illustration of what well-directed and untiring energy can do.

The foundation had much the appearance of an immense flat-bottomed scow. Upon this was a 60-ft. octagonal casemate with sloping sides and plated with two layers of 2-in. iron. Like all the Confederate iron-clads, the *Albemarle* had no engines that could properly propel her. Had she been otherwise provided in this respect, it is quite probable that she would, temporarily at least, have cleared the sounds of North Carolina.

At Charleston four iron-clad rams were built, but beyond a single raid, in which one wooden gun-boat was completely disabled and another compelled to surrender, nothing was accomplished. All were captured or blown up at the capture of the city.

Of the three iron-clads that formed the James River fleet only one needs mention—the *Virginia* (not of *Monitor* fame)—from the fact that she was provided with heavier armor than any other Confederate iron-clad, 6 in. side and 8 in. end armor on her casemates. None of them took a prominent part in hostilities, but the moral effect of their presence as a factor in the defense of Richmond was not inconsiderable. They were destroyed upon the evacuation of the city.

For the defense of New Orleans and the lower Mississippi, the iron-clads *Louisiana* and *Mississippi* were designed. The latter was never completed, and the former was barely so when Farragut forced the defenses of the city. Her engines were so inadequate that her only part in the defense was that of a floating battery. Her casemate was armored with railroad iron, of which several hundred tons were used. She was set on fire and blown up by her commander.

On the Yazoo River the Confederates completed the *Arkansas*. Unlike their other casemated iron-clads, the ends of the casemate only were inclined. Iron taken from railroad tracks supplied the armor. The rails were placed horizontally along the sides and up and down on the ends, and dovetailed together. With a substantial wood backing this improvised armor gave a remarkably good account of itself during subsequent operations.

The weak point in every one of the Confederate iron-clads lay in their machinery. None of them had engines that could propel them more than six knots an hour under the most favorable conditions, while many of them could hardly be given steerage way. What the *Albemarle*, the *Arkansas* or the *Tennessee* could have done if provided with powerful machinery can well be imagined. Generally speaking, their armament consisted of 6 and 7-in. converted rifles.

XIII.—THE TEST OF BATTLE.

In February, 1862, the first armor-clad vessels built in the United States received their baptism of fire. When the advance against Forts Henry and Donelson had been decided upon by General Grant, four of the eight iron-clads built by Captain Eads were ordered to co-operate, under Flag-Officer Foote. These boats were under control of the War Department, and a detail from the Army had been promised to help man them. Only a small detachment reported, and so difficult was it to obtain men that four of the iron-clads were left behind for want of proper crews.

In the attack on Fort Henry, the Confederates brought 11 guns to bear—a 60-lb. rifle, a 10-in. columbiad, and the remainder 32 and 42-lb. smooth-bores. It will be remembered that these vessels were armored only on the front ends of their casemate and abreast the machinery on the sides. The action opened at 1,700 yards, and the distance was gradually reduced to 600, and was continued a little more than an hour. The flag-ship was struck 32 times and one of her consorts 30 times. Although the armor was in many places badly shattered, the general result of this, the first test, was to demonstrate the ability of even 2½ in. of inclined iron armor to keep out any projectiles likely to be encountered on the Western rivers. The great defect in these vessels, as shown by this action, was the leaving of so large a portion of the sides unprotected, and the neglect to provide armored shutters for the gun-ports. Smoke-stacks were badly damaged, and we read of after-cabins being riddled with shot and of guns disabled by shot coming through the ports or unarmored sides. The most serious mishap was that of a shot coming in over one of the bow-guns of the *Essex* and entering one of the boilers. Twenty-eight of the 39 casualties which occurred in the fleet were from escaping steam in this instance.

At the end of the hour the batteries on shore were in a sorry plight. The 60-pounder rifle had burst; the columbiad became accidentally spiked, and five of the remaining guns had become disabled. A storm had delayed the troops, so that the action was fought and won by the gun-boats, to whom the fort surrendered.

At Fort Donelson, a week later, the fighting qualities of the iron-clad gun-boats were put to even a severer test than the one just mentioned. The position of the Confederate batteries, 30 odd feet above the river, gave them a plunging fire upon the gun-boats. Their armament was 12 guns, principally 32-pounders. The fight opened at a mile range and was continued down to 400 yards, and lasted an hour and a half—four iron-clads taking part. The wheel of the flag ship and the tiller-ropes of another were shot away about the same time, and both boats drifted helplessly out of action, which practically ended the attack. The flag-ship was struck 59 times, and all were well battered. The armor-plates were badly cracked and broken in places, but the armored portions of the vessels were nowhere penetrated. The pilot-houses suffered the most; the flag-officer was severely and four pilots mortally wounded, or killed outright.

A month after the Western gun-boats had had their test of battle came the first fight of the iron-clads. It was the first recorded instance wherein we have the spectacle of two armored war-ships meeting in battle. It was turret against casemate. In it the 8-in. turret armor of the *Monitor* was pitted against the 4-in. inclined armor of the *Merrimac*. In armament, the two 11-in. Dahlgrens of the one were opposed by the 10 guns—six 9-in. and four 6 and 7-in. converted Brooke rifles—of the other. The *Monitor* fired 43 rounds during the engagement against perhaps twice as many by her antagonist. Although fought almost muzzle to muzzle, no permanent injury was inflicted upon either side. The report of the *Merrimac* says that the marks of 97 shot were found on her casemate; that six of the top layer of plates were broken—none of the lower layer—and that the backing was uninjured. The *Merrimac* had received the broadsides of the *Congress* and *Cumberland* at close range, as well as several from the *Minnesota*. But while the armored portions had received little injury, everything outside was destroyed. The smoke-stack, steam-pipes and an anchor were shot away, together with railings, boat-davits and the like. A loss of 21 killed and wounded was reported. The *Merrimac* fired shell principally, from which it appears that there was no expectation, when she went out, that she would be called upon to engage anything but wooden vessels.

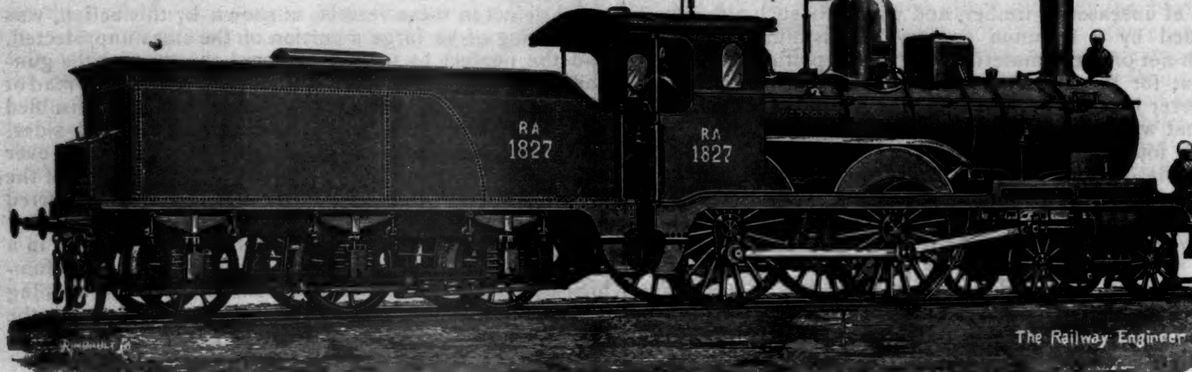
The *Monitor* was struck by 21 shot, seven of which were upon the turret. The only serious casualty was that to Captain Worden, in the pilot-house. Her projectiles were 168 lbs. solid shot. Some hammered wrought-iron pro-

jectiles had been provided, but they had been hurriedly finished and, owing to fear of jamming, were not used. The small damage inflicted upon the casemate of the *Merrimac* is in a great measure explained by the fact that with her 168 lb. projectiles a charge of only 15 lbs. of powder was used, giving a striking energy of but about 1,300 foot-tons. These guns were afterward fired with double this weight of powder.

(TO BE CONTINUED.)

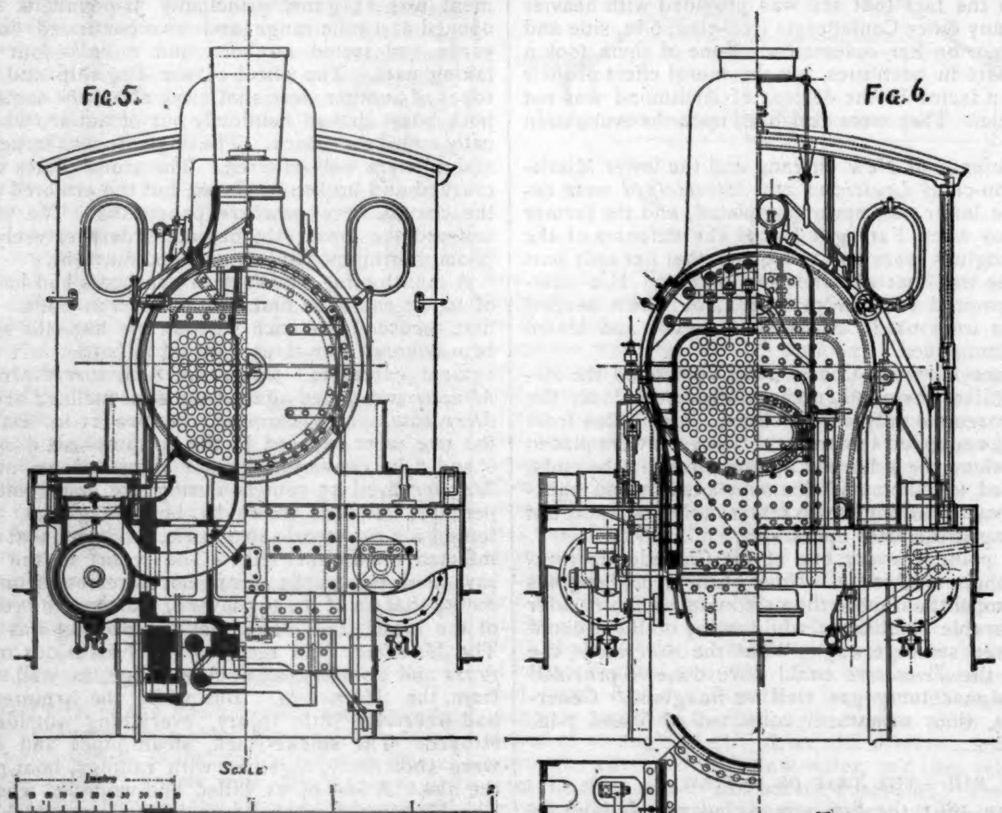
AN ITALIAN PASSENGER LOCOMOTIVE.

THE accompanying illustrations, which are taken from the London *Railway Engineer*, show an engine and tender



EXPRESS PASSENGER LOCOMOTIVE, SOUTHERN RAILROAD OF ITALY.

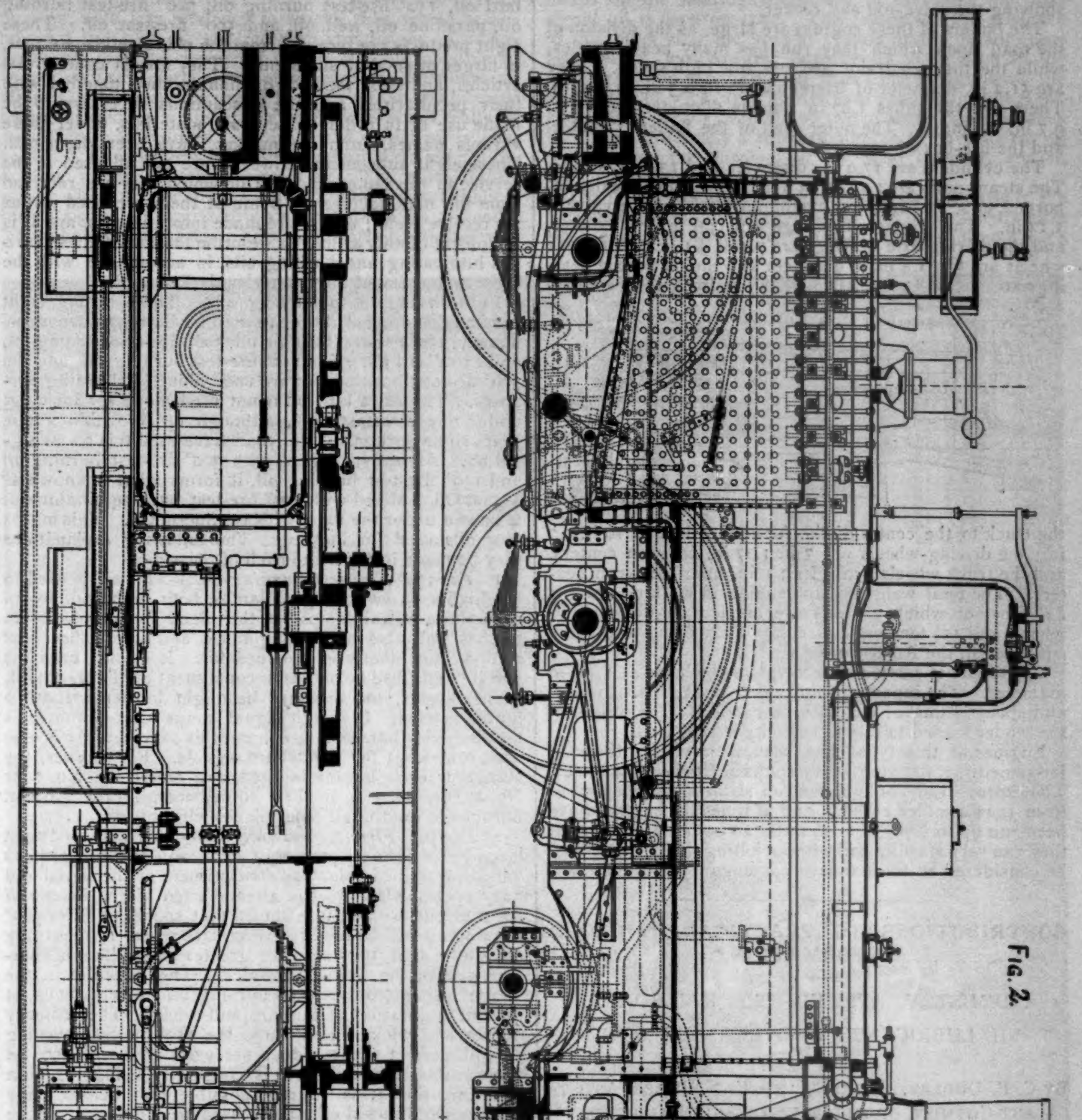
which were exhibited at Paris last year by the Southern Railroad Company of Italy, and which were built at that



company's works in Verona. The engine was designed by Sr. Commendatore Saverio Agazzi, Chief Locomotive Superintendent of the road, and built under the superintendence of Sr. Enrico Riva, Superintendent of the shops. It is one of 30 of the same pattern which have been in service for a year or more on the Adriatic Division of the road.

The principal point to be noted is that in all the more important respects the engine is of the American type. The four-coupled drivers, the four-wheel truck, the outside cylinders with the steam-chests on top, the shifting link and the valve-rods worked from a rocker-shaft are the distinctive features of the engine, and the truck itself is of the swinging-bolster type.

In the accompanying illustrations the first is a general view of the engine and tender; fig. 2 is a longitudinal section of the engine; figs. 3 and 4 are each half horizontal sections; fig. 5 shows the front end, one-half in elevation and one-half in section; fig. 6 shows the back end, also one-half in elevation and one-half in section; fig. 7 is a cross-section showing the arrangement of the rocker-box,



EXPRESS PASSENGER LOCOMOTIVE, SOUTHERN RAILROAD OF ITALY.

etc., and fig. 8 a section of the cylinder and steam-chest showing the valve-rod and rocker.

The boilers of these engines are large, as the division of the road upon which they run has many heavy grades, while the through trains are run at a high speed. They are 51.2 in. diameter of barrel and 12 ft. 0.3 in. in length. There are 181 tubes 1.97 in. outside diameter and 11 ft. 9.7 in. in length. The outer shell of the boiler is of steel and the fire-box of copper.

The cylinders are 17.9 in. diameter and 23.6 in. stroke. The steam-ports are 1.18 × 13.8 in. in size and the exhaust-ports 2.36 × 13.8 in.; the maximum travel of the valve is 5.12 in. The driving-wheels are 6 ft. 3.6 in. in diameter, and the driving-axle bearings are 7.1 × 9.1 in. The truck wheels are 3 ft. 1.4 in. in diameter and the truck axle bearings are 5.5 × 8.7 in. The distance from the center of

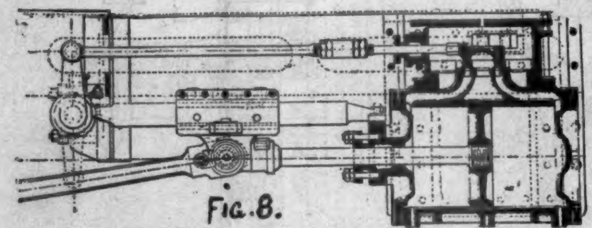


FIG. 8.

the truck to the center of the forward driver is 10 ft. 0.7 in.; the driving-wheels are 7 ft. 11.7 in. between centers, and the truck wheels are 6 ft. 3.7 in. apart between centers. The total weight of the engine in working order is 43¼ tons, of which 28 tons are carried on the driving-wheels and 15¼ tons on the truck. The driving-wheels are equalized in the American style.

The tender is carried on three pairs of wheels 44.1 in. in diameter. The capacity of the tank is 4,933 galls. of water, and about 4½ tons of coal can be carried. The weight of the tender loaded to its full capacity is 24.9 tons.

Engines of this type have been in service on the road for some time, drawing heavy trains of from 40 to 44 axles. The express trains of this line run at an average speed of from 34 to 40 miles an hour, and at times the engines have been run up to from 50 to 56 miles an hour; at that speed they run very steadily and without jolting. They may now be considered as the standard passenger type of the road.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.

VII. LUBRICANTS AND BURNING OILS.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(*Continued from page 226.*)

IN the articles of this series which have preceded, the following kinds of oil, for lubrication and burning, have been described—namely, tallow, extra lard oil, extra No. 1 lard oil, 150° fire-test burning oil, 300° fire-test burning oil, paraffine oil, well oil, and 500° fire-test oil. These eight products are received from the manufacturers direct, in larger or smaller shipments. They are all commercial articles, and their methods of manufacture, together with their peculiarities and the precautions necessary to be made use of in order to get good materials, under these various names, from the market, have been described. These eight substances, however, are not all used in the service in the same condition in which they are received from the manufacturers. Some of them are used just as we receive them; others are made into mixtures, and it is the object of this article to describe the use of these various lubricating and burning oils, in accordance with the present practice of the Pennsylvania Railroad.

First, in regard to burning oils. Three of the eight products mentioned above are used for burning purposes—namely, 150° fire-test burning oil, 300° fire-test burning oil, and extra lard oil. The 150° fire-test burning oil, and the 300° fire-test burning oil, are used alone for burning purposes. The extra lard oil is not used alone for burning, under any circumstances, although up to within a few years some portions of the road have used this oil as signal oil. At present mixed with 300° fire-test burning oil and 150° fire-test burning oil, it forms what is known as Signal Oil. Mixed with 300° fire-test burning oil alone, it is known under the name of Navy Sperm Oil. This makes four oils used for burning. The following explanations may be made in regard to each of these oils.

1. *The* 150° *Fire-test Burning Oil.*—This oil is used in headlights, in switch signal lamps, both high and low, in semaphore signal lamps, at the block signal towers, in torches, and also for lighting ticket and other offices and stations not otherwise provided for. It is also used, as will be described below, as a constituent of the signal oil. In headlights, the ordinary headlight burner without a button is used. In switch signal lamps what is known as the thin-wick burner is used, and this same burner is also used somewhat for semaphore signals. For torches, the standard torch burner is used, and either the No. 1 or No. 2 Sun burner, or their equivalents, or the Argand burner are used in all other places with this oil.

2. *The* 300° *Fire-test Burning Oil.*—This oil is used most largely for lighting passenger cars, and is also used, as will be described below, as a constituent of the signal and navy sperm oils. As has already been hinted in one of the previous articles, it is hoped that sooner or later 300° burning oil will be used in every place where 150° burning oil is now used, thus securing greater safety than is characteristic of the present practice. The difficulty in the way of using 300° fire-test burning oil universally is at present a question of burners and wicks. The ordinary burner and wick, which burns the 150° fire-test burning oil with perfect success, does not work well with 300° oil alone. Progress, however, is constantly being made in this line, and it is entirely possible that before many months 300° fire-test oil may be used to the almost entire exclusion of 150° oil.

3. *Signal Oil.*—This is one of the most important oils used on a railroad. What is known as signal oil is universally the oil for the hand lanterns, and on the Pennsylvania Railroad the rear-end signal lanterns on passenger trains use the same oil. A large number of experiments have been made to get a good mixture which will be perfectly satisfactory as a signal oil. At present the signal oil on the Pennsylvania Railroad is made of four parts extra lard oil, five parts 300° fire-test burning oil, and one part 150° fire-test burning oil. The flashing point of this oil is about 221° Fahrenheit, and the burning point about 270°. The old signal oil, which was used with great success for many years on most of the railroads of the country, was a mixture of two parts extra lard oil and one part 150° fire-test burning oil. Later it was found that a percentage of 300° burning oil could be introduced into the mixture with no detriment so far as light and burning were concerned, and some roads, we believe, have used a mixture of extra lard oil and 300° fire-test oil alone. It will be observed that a percentage of 150° fire-test burning oil is retained for the present in our signal oil mixture.

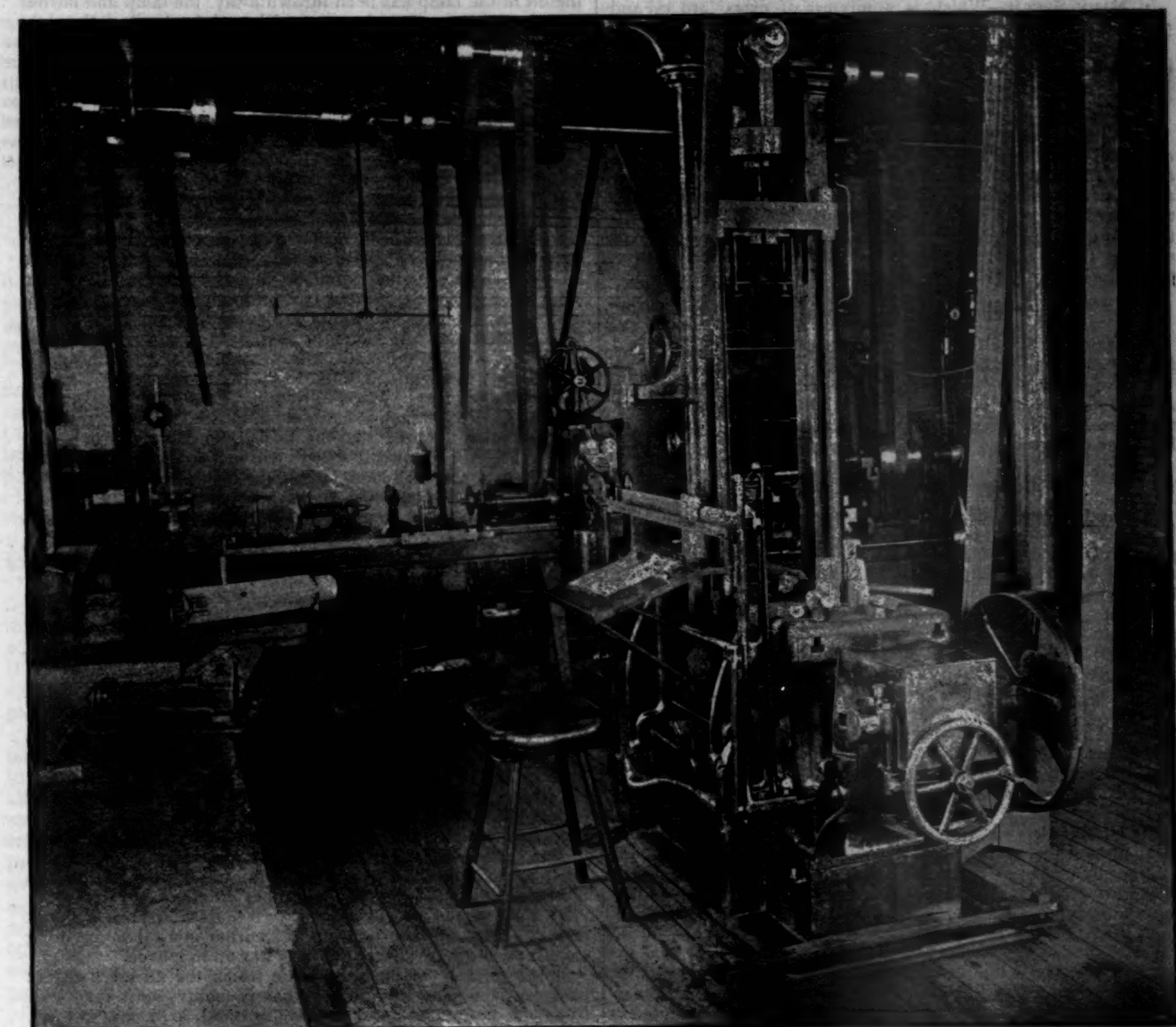
* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, is on the Work of the Chemist on a Railroad; No. II, in the January number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION of special value in indicating the true character of the materials they must use and buy.

There are certain advantages connected with this percentage of 150° oil—namely, a better cold test and a little freer burning, with less tendency to smoke than would be obtained if the 150° oil was removed completely. Our experiments indicate, however, that it is quite possible to have a very successful signal oil without any 150° burning oil in it, and should the use of the 150° oil for this purpose be abandoned, as is hinted at above, there would really be no difficulty introduced, so far as the signal oil is concerned. The burner used with signal oil is simply a tube, holding a very loosely woven wick. The more tightly woven wick used for the petroleum products is not applicable to signal oil, apparently on account of its viscosity. The tube is usually fitted with slots for picking up the wick instead of the wheel arrangement which is common with the petroleum products. Many efforts have been made to introduce the wheel arrangement on hand lanterns, but the wick that gives best results with signal oil is so soft and loosely woven that difficulties frequently arise in attempting to use the wheel arrangement for adjusting the wick in hand lanterns. We know that some roads use them, but we have never felt willing to recommend them on account of the tendency to substitute the petroleum wick for the regular signal oil wick, to avoid the difficulty above mentioned.

4. *The Navy Sperm Oil.*—This oil, which is used on the floating equipment, differs from signal oil simply in being made of half extra lard oil and half 300° fire-test burning oil. It is used in hand lanterns and petticoat lamps on the floating equipment, in the same way that signal oil is used on land. The reason for the existence of this oil is, that the laws of certain States do not allow less than a 300° fire-test burning oil to be used on the floating equipment. This oil works charmingly with the same kind of wick and burner as is used with signal oil, and as has already been stated two or three times, it looks as though ultimately a mixture similar to navy sperm oil will become the burning oil for hand lanterns, and in lamps throughout the whole road.

The difficulties arising in the service from the use of the various kinds of burning oil during the past 15 years have been carefully investigated, and a study of almost each individual case has been made. Moreover, the interests involved in signals are so tremendous, it has been felt that any amount of study and care was not too great to secure an oil which would give perfectly reliable and satisfactory results. Some two or three years ago the results of the investigation of all the cases of signals which had failed or given difficulty in service were brought together, and a circular of instructions to the men drawn up embodying the results above referred to, and giving instructions as to how to avoid these difficulties in future. This circular is given in full below, and since its issue the complaints in regard to failure of signals and difficulties with the lamps have diminished quite largely. The following is the circular:



PHYSICAL TESTING ROOM OF THE PENNSYLVANIA RAILROAD LABORATORY, ALTOONA.

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

Information and Instructions in Regard to Burning Oils and the Care of Lamps.

The oils used for burning are:

1. 150° FIRE-TEST OIL—Known also as "Head Light Oil" and "Carbon Oil." The "Kerosene Oil" of market is the same in kind, only lower in fire test, and cannot be used in place of 150° oil.

2. 300° FIRE-TEST OIL—Known also as "Mineral Sperm," "Mineral Seal," "Golden Light," and "Sunlight" oil.

3. SIGNAL OIL—Which is a mixture of extra lard oil, 150° oil and 300° oil.

4. NAVY SPERM—Which is a mixture of extra lard oil and 300° oil.

The 1st and 2d are petroleum, and the 3d and 4th fatty burning oils.

THE 150° FIRE-TEST OIL.

A tightly woven compact wick should be used.

It will burn successfully with any good burner that has a chimney, either Dual, Argand, or any of the numerous kerosene oil burners of the market; it also burns well with a wick as above in a number of no-chimney burners to be found in the market; it gives satisfactory results without a chimney, with the thin-wick burner, but in this case a special thin wick adapted to the burners must be used. It works well also in torches with any good torch wicking.

THE 300° FIRE-TEST OIL.

The same kind of tightly woven compact wick as described for 150° fire-test oil should be used.

It always requires a chimney, and either the Dual or the Argand burner; it works best with the Dual, is less satisfactory with the Argand, and gives very poor results with the ordinary kerosene oil burners.

THE SIGNAL AND NAVY SPERM OIL.

A loosely woven wick should be used.

Neither will burn successfully with the tightly woven compact wicks used with the petroleum oils. The wicking best adapted to fatty burning oils is known in the market as No. 1 lard oil wicking.

Neither requires a chimney and the burners need be little more than tubes, in which the wick fits closely enough to maintain itself in place, having slots for adjustment.

The tubes may be round or flat, and the hand wheel or pinion used in adjusting the wicks of petroleum burners should not be used.

Any of these four oils may give bad results from the following causes:

1. *Clogging of the wick.*—There may be two causes for this—1st, it is impracticable to keep either the lamps or the oils, before they are put into the lamps, free from fine particles of dust and dirt, and the wick being a filter, sooner or later becomes clogged with this dust and dirt. 2d. All the oils undergo slow changes by exposure to the light and air, which seem to result in the formation of tarry or gelatinous matter which clogs the wick and prevents it from doing its work satisfactorily.

2. *Wicks fitting too tightly or too loosely in the tube.*—The effect of the wick being too tight is to prevent the oil flowing to the flame, and if too loose it frequently jars down and diminishes or extinguishes the light.

3. *Use of the wrong wick.*—The closely woven compact wick will not burn signal oil or navy sperm oil successfully, and should not be used with them.

The loosely woven wick will burn the petroleum oils successfully, but its loose texture gives much difficulty with the hand wheel or pinion used with the compact wick, so that it is not advisable to use it with the petroleum oils.

4. *Wicks of inferior quality.*—This is of very rare occurrence.

5. *The oil being too old.*—This may occur with any of the four oils mentioned. It is least likely to cause trouble with 150° oil, rather more so with 300°, but signal oil and navy sperm oil often give difficulty from this cause. The petroleum oils six months old rarely give serious difficulty, but the fatty oils three months old will almost certainly give trouble. This is true of the oil in the lamp as well as of the oil in cans or barrels. Where lamps are little used the age of the oil is not unfrequently the cause of trouble. When lamps are filled with fresh oil, and burned every day, the difficulty due to old oil is greatly diminished, but all lamps sooner or later will give difficulty from this cause.

6. *Different oils mixed in the same lamp.*—A small amount of 150° oil mixed with either of the other oils will cause no difficulty; a large amount would make 300° oil more dangerous, but would not seriously affect it otherwise. It would cause the signal oil and navy sperm oil to smoke badly, and make them both dangerous to use.

A small amount of 300° oil mixed with 150° oil would diminish the light, and a larger amount would have the same effect in a greater degree. A small amount of 300° oil added to either signal oil or navy sperm oil would have very little effect. A large amount would make both of them smoke, and would increase the danger of these oils.

A small amount of either signal oil or navy sperm oil mixed with either 150° or 300° oils is a very serious matter. The light diminishes and the wick begins to crust at once, and no further satisfactory results can be obtained from that lamp until the oil in the lamp has been thrown away, the lamp and burner thoroughly cleaned, and a new wick and fresh oil of the right kind put in the lamp. A large amount of signal oil or navy sperm oil with either of the petroleum oils increases the difficulty, and indeed may cause the light to go out entirely.

Mixing signal oil and navy sperm oil in the same lamp is followed by no serious difficulties, but signal oil should never be mixed with navy sperm on the floating equipment.

7. *Congealed oil in lamps.*—This difficulty occurs with the fatty oils, and occasionally with 300° oil. The 150° oil rarely gives trouble from this cause. When this difficulty occurs it is evident either that the lamp is not sufficiently well protected, or that an attempt has been made to use an oil unadapted to the situation. The navy sperm oil congeals so as to give trouble at 50° Fahrenheit, the signal oil at 40° Fahrenheit, the 300° oil at 25° Fahrenheit, and the 150° oil in general at zero Fahrenheit, although some shipments are perfectly clear at 20° below zero Fahrenheit. As more or less heat is always conveyed from the burner to the lamp, it is probable that all of these oils can be used in situations from 10 to 20 degrees lower than the figures above given. Many devices have been used for keeping the oil in exposed lamps fluid, most of which depend on utilizing some of the heat from the burner for this purpose. It is best to use always an oil which will not congeal in the situation, or to protect the lamp so that the oil will not congeal; but if from any cause oil must be used which congeals in the situation, it is advisable to use some of the devices above referred to.

8. *Cloudy oil.*—This occurs mostly with the petroleum oils, but may also happen with the fatty oils. In the fatty oils the cloudiness is due to finely suspended dirt or dust, or to gluey or gelatinous matter which comes originally from the lard oil used in compounding signal and navy sperm oils. In these oils the cloudiness will generally disappear if the oil is allowed to settle. In the petroleum oils the cloudiness is generally due to gluey matter from the inside of the barrels, put in to make the barrels tight, or possibly to watery sedimentary matter left in the oil at the works during the process of purification. Both these difficulties are due to carelessness at the oil refineries, but their effects are most disastrous. A lamp in perfect order, filled once or twice with cloudy 150° or 300° oils, will ever after give unsatisfactory light, no matter how much good oil is subsequently added, until the wick and cloudy oil in the lamp are thrown away, the lamp cleaned, and a new wick and fresh, good oil supplied. Cloudy petroleum oils probably occasion more difficulty in lamps than any other single cause.

9. *The oil level too far away from the flame.*—This is a fault in the construction of the lamp and burner more than anything else, though the texture of the wick has an influence.

It is desirable to have lamps in which the oil level cannot become, even when the lamp is nearly empty, more than 5 in. from the bottom of the flame for 150° oil, 4 in. for 300° oil, and 3 in. for the fatty oils. In general an effort should be made by frequent filling to keep the oil level as near the bottom of the flame as possible, but this should not be construed as permitting a lighted lamp ever to be filled.

10. *Miscellaneous causes.*—It is not necessary to remark upon the difficulties which may arise from such obvious causes as "burner out of repair," "burner tube choked with crust," "no oil in the lamp," "want of trimming," "dirty chimneys," "wick too short to reach the oil level," or "lamp so situated that it blows out."

Whenever a lamp gives unsatisfactory light, proceed as follows:

1. If the difficulty arises from any of the causes mentioned in Section 10 above, apply the appropriate obvious remedy.

2. If the oil is congealed, use a different oil, protect the lamp better, or use some device to keep the oil fluid.

3. If the wick is of the wrong kind, too tight or too loose, change it.

4. Put in a new wick which will remove the difficulty if it is due to the old wick having become clogged.

5. If none of the above directions remove the difficulty, burn the oil down low, throw away the wick and the oil left in the lamp, and also the oil supply in the can, clean the lamp, burner, and can thoroughly, and start afresh with a new wick and new oil.

6. If the difficulty still continues, shake the oil-can thoroughly, pour out a little of the oil into a glass bottle, and see if it is cloudy. If so send a bottle of it to the Superintendent Motive Power for examination. At the same time, get a new supply of clear oil, also burn the oil down low, throw away the oil and wick, clean the lamp and start afresh with clear oil.

7. As a final resort, send the lamp, the wick, and, if possible, not less than a quart of the oil to the Superintendent Motive Power, with a letter stating what the difficulty is, and where the oil and wick were obtained.

All persons in charge of oil supplies will be held strictly responsible for giving out into the service any cloudy oils. Signal oil and navy sperm oil should always, if possible, be held in tank long enough to settle clear. If this is not possible it should all be filtered through heavy canton flannel. As soon as a shipment of 150° or 300° oil is received each barrel should be rolled about, so that the oil is thoroughly mixed, and then a sample examined to see if the oil is cloudy. All barrels containing cloudy oil must be set aside and not used.

Approved: June 13, 1887.

Theodore N. Ely,
General Superintendent Motive Power.

Second, in regard to lubricating oils, the five other products mentioned above—namely, the extra No. 1 lard oil, paraffine oil, well oil, 500° fire-test oil, and the tallow are used for lubrication, some of the materials being used pure and simple as we receive them, and others mixed. The extra No. 1 lard oil is not used alone for lubrication except in special cases. On fast passenger trains it is sometimes used in the car boxes, and sometimes also in the very hot weather it may be used alone as engine oil on locomotives. The tendency of the practice during the past few years has been, however, toward using some sort of a lubricating grease instead of extra No. 1 lard oil on the fast passenger trains. The principal use of extra No. 1 lard oil is as a constituent of engine oil, as will be described below.

The well oil is used exclusively for freight car lubrication in the car boxes. In certain portions of the service it may be used likewise on passenger trains in the boxes, and also in passenger and freight engine tender trucks. It is also used for miscellaneous greasing in the foundries, and also in making passenger car oil for a portion of the passenger car equipment.

The engine oil is at present a mixture of half extra No. 1 lard oil and half paraffine oil. This is, perhaps, the most important lubricating oil used on the road. It is used on all engine machinery, in engine and tender truck boxes, except as previously specified in certain portions of the service. It is used on shafting everywhere in the shops, for machine tools, bolt cutting, and for general lubrication everywhere except passenger and freight cars. Many experiments have been made with mixtures of lard and paraffine oils to arrive at the best results. At one time mixtures of two-thirds lard and one-third paraffine oil were used on passenger engines, and one-half lard and one-half paraffine oil on freight engines. Again, a summer engine oil and a winter engine oil were made, the winter engine oil differing in having a larger percentage of paraffine oil on account of the cold test. Furthermore the market has frequently furnished different grades of paraffine oil, with the claim that more of this special paraffine oil could be used in making engine oil with economy, since the paraffine oil is much cheaper than lard oil. Many experiments have been made on this point, some of which seem to indicate that an engine oil of three-quarters paraffine oil and one-quarter extra No. 1 lard oil would work satisfactorily. All these mixtures, however, have produced no permanent change in the engine oil mixture, which has been used as above stated for now some 10 years or more without change. Certain portions of the service, especially those having lighter pressures, could use a larger percentage of paraffine oil, and also certain portions of the engine service could use an oil with a larger percentage of paraffine oil in it; but the introduction of a large number of oils, differing from each other in the proportions of their constituents, introduced such difficulties into the service that all attempts to produce these very small economies have been abandoned, and one engine oil is used for all general lubrication. The difficulties of having a number of different kinds of lubricating oils, differing in proportions of the same ingredients, are liability of confusion in using the various oils, since they cannot be identified by simple inspection, and the complications which arise from the necessity of keeping a number of oils in stock at each place where they are given out to the service.

There are certain peculiarities in the service which this uniform grade of engine oil does not cover to perfect satisfaction—namely, extremes of hot and cold weather. In the extreme hot weather the engine oil is a little too limpid for crank-pins, although working well in other places, and in the extreme cold weather, although a cold test is enforced as severe as the ingredients will bear, the engine oil is frequently too stiff for satisfactory service. Both these emergencies are met when they arise on the engine. Every engineer carries a little tallow or a little extra No. 1 lard oil for the hot weather emergencies, and for the cold weather emergencies it is not at all uncommon to mix headlight oil with the engine oil. It is deemed advantageous to have these emergencies met by the engineers as they arise rather than to attempt to furnish an oil which would meet the requirements, and would at best, perhaps, only be used a few days at a time. So successful has the engine oil on the Pennsylvania Railroad been, that any attempts to change the oil meet with considerable opposition from the service. We really would hardly know how to make a single oil for general lubrication everywhere which would meet the requirements better than the above mixture.

The passenger car oil, which is not universally used for passenger cars, is a mixture of one-third extra No. 1 lard oil and two-thirds well oil. Many of the branch roads, and indeed some portions of the main line, use well oil in passenger car boxes with perfect success, and where the speed is not above 25 to 30 miles an hour there seems to be very little difficulty with common well oil in the passenger car boxes. Where the speed is higher than this, and especially where there are frequent trains, causing much dirt, something rather better seems to be required, and for this purpose the passenger car oil was devised. It is almost as good as the extra No. 1 lard oil, and when it was first used in many places took the place of extra No. 1 lard oil.

For cylinder lubricant the practice of the road is quite varied. In some places tallow alone is used. This practice, however, is being abandoned, and it seems probable that within a year tallow alone will not be used anywhere. At present its use is confined almost exclusively to places where facilities for mixing the lubricant do not exist. In all places where facilities for mixing do exist the standard lubricant for locomotives not fitted with sight-feed cups is two parts tallow and one part 500 fire-test oil. This lubricant is used in the intermittent way, in the old-fashioned tallow cups or through tallow pipes from the cab. In all cases where engines have been provided with sight-feed cups the standard cylinder lubricant is three parts 500° fire-test oil and one part extra lard oil. Also on stationary engines and on the marine equipment in steam cylinders 500° fire-test oil alone is used as cylinder lubricant. The experience of the road indicates that where tallow has been used as cylinder lubricant, it is unwise to pass immediately from tallow to a lubricant containing a large percentage of petroleum products The reason for this is that the tallow contains free acid, as has already been described, which acts on the iron of the cylinders and valves, forming an iron soap which remains in all the crevices. The petroleum dissolves this, and if it is dissolved in large quantities at one time it causes the valves and pistons to stick and makes the friction very great. In passing from tallow to any cylinder lubricant containing large quantities of petroleum, the change should be made slowly. A mixture of two parts tallow and one part 500° fire-test oil should be used for a few months, and then perhaps the standard lubricant for sight-feed cups could be used with success. Many experiments have been made to see if the petroleum products alone

would not be satisfactory as locomotive cylinder lubricant, and while it is hoped that possibly as time progresses the amount of lard oil used in the standard locomotive cylinder lubricant with sight-feed cups may be diminished, no experiments yet have been successful in which a 500° fire-test oil alone was used. The reason why extra lard oil is used in making cylinder lubricant is because it contains much less free acid than the extra No. 1 lard oil, and very great care is taken not to use extra No. 1 lard oil in making this lubricant.

For the sake of completeness we may add that in the shops, on machine tools, an emulsion of sal soda, water, and oil is used, the idea being that the water serves to keep the cutting tool cool, while the oil serves to lubricate it. This emulsion is called "Soda Mixture for machine tools," and is made by dissolving 5 lbs. of sal soda in 40 gallons of water and stirring thoroughly. When needed for use about half a pint of engine oil is put in a suitable vessel and a gallon of the soda mixture added, and the two mixed thoroughly. This material works very nicely, and is used over and over again. Small tin cans fitted with faucets and tubes are used for feeding it to the tool in a rather free stream, and pans underneath the machines, which catch the chips, also catch the liquid, which may be used more than once.

It will be observed that there are some 15 oils used for burning and lubrication, of which eight are obtained from the market and seven are mixtures made by the railroad companies for their own use; four of the 15 are used for burning and 11 for lubrication.

Notwithstanding the amount of work that has been put on lubricants and burning oils, and notwithstanding the standard practices which have been described either above in this article or in the previous articles, the subject is not regarded as exhausted. Constant study is being put on possible modifications of the lubricants and burning oils which will result in greater efficiency and at the same time greater economy. With the increase of speeds and pressures, which is characteristic of modern progress in railroading, the lubrication problem is becoming more and more difficult, and it seems probable that modifications in the lubricants will be necessary as time progresses. Also with higher speeds the signal lamps used on engines will give greater difficulty, and it is entirely possible that modifications in burning oils to meet this difficulty may be required.

In the next article of this series we will describe the method of purchasing oils in use, and also have something to say about hot-box and lubricating greases.

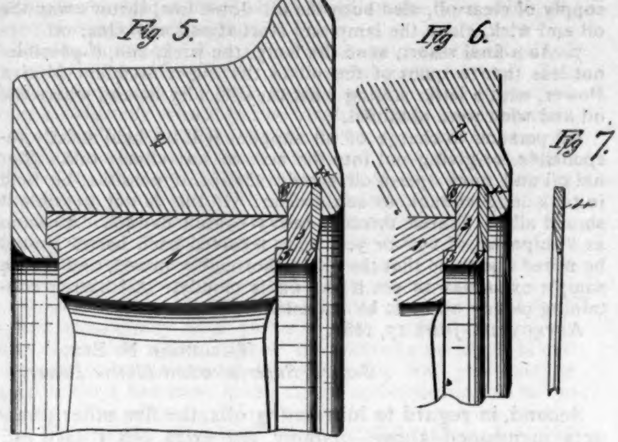
(TO BE CONTINUED.)

Recent Patents.

I.—METHOD OF FASTENING TIRES.

FIGS. 5, 6, and 7 show a method of fastening tires, for which Patent No. 415,745 was granted, under date of November 26, 1889, to William Stroudley, of Brighton, England. It is described by the inventor as follows: "This invention has for its object to dispense with or reduce the hammering of the tire, which has been usual according to the method of attachment, thus obviating the risk of fracture and enabling a much harder and more durable steel tire to be employed. To this end a ledge, shoulder, or check is formed on the outside of the inner or clip-ring, near its inner circumference. This inner or clip-ring is secured in position by means of a wedge or lewis-ring, which is either cut across and sprung in behind the inner or clip-ring or is inserted in two or more parts, filling the vacant space in the groove formed in the tire to receive the clip-ring. The wedge or lewis-ring is beveled or chamfered for a portion of its breadth at its inner side, and when in position is laid down by a hammer, by which its chamfered side is applied closely to the clip-ring, and its inner edge is made to surround the ledge, shoulder, or check formed on the clip-ring. The lewis-ring is thus prevented from leaving the groove, while at the same time it secures the clip-ring accurately in place without being made of the taper form within the groove, as heretofore. This construction gives an additional support or buttress should the tire break into short pieces, and prevents the edge of the clip-ring from leaving the rim of the wheel. Both rings may be made of mild steel, the lewis-ring being somewhat softer than the clip-ring, so that it may be laid down with a hammer into its place. This hammering will of itself stiffen and harden the ring. Thus the flange or clip of the tire itself will not require to be struck with a hammer, as with the construction hereinbefore referred to, or if at all only very lightly.

"There are several ways of getting both the clip-ring and the lewis-ring into position. One way is to make across the ring a



STROUDLEY'S METHOD OF FASTENING TIRES.

cut and to chamfer the ends at each side of the cut to admit of springing the ring into place. Another and a better way is to cut out of the ring a piece of sufficient length to allow the remainder to be sprung into place, the smaller piece being afterward inserted to complete the ring in place. The ring may, however, be inserted into position in several pieces.

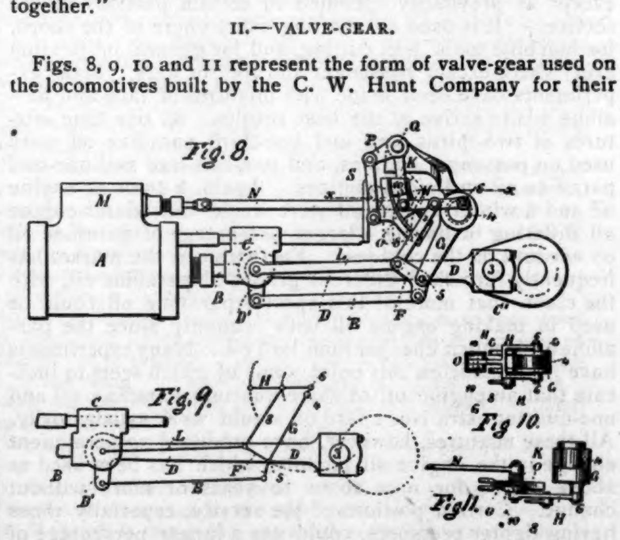
"On the accompanying sheet of drawings, fig. 5 shows in section so much of one form of a wheel-body and tire as is needful to illustrate this invention. Fig. 6 is a similar view to fig. 5, showing the lewis-ring as it appears before it is hammered or laid down onto the clip-ring as it is shown in fig. 5. Fig. 7 shows a section of the lewis-ring.

"In these 1 is the wheel rim or body; 2, the tire; 3, the clip-ring; 4, the wedge or lewis-ring.

"The clip-ring has on one side two annular lips or lugs 5 6, the one engaging with the rim or body and the other with the tire. At its opposite side it has a ledge, shoulder, or check 7. The upper portion of the clip-ring lies within a groove in the tire and is held in place by the wedge or lewis-ring 4, which is inserted into the groove behind. The wedge-ring in this example is of the shape shown in fig. 7, and when it is first put into place its beveled part occupies the position shown in fig. 6. It is then laid down into the position shown in fig. 5 and securely locks the wheel-body, the tire, and the ring 3 all together."

II.—VALVE-GEAR.

Figs. 8, 9, 10 and 11 represent the form of valve-gear used on the locomotives built by the C. W. Hunt Company for their



HUNT'S LOCOMOTIVE VALVE GEAR.

narrow-gauge roads, which were described in the November, 1889, number of the JOURNAL. This valve-gear is the invention

of Mr. Hunt, and has been patented by him, and is described in his specifications as follows :

"I make use of a connecting-rod in the form of a bent lever, the short arm of which gives a rocking motion through a link to a rocker pivoted upon a swinging radius-arm, and the valve receives its motion from a swinging link and block moving within a slotted sector.

"The special feature of the improvement relates to the combination, with the parts before mentioned, of an eccentric pivot between the swinging link and the radius-arm, whereby the radius-arm in its movement varies the position of the pivot of the swinging link sufficiently to produce the lap and lead required of the valve in the engine.

"In the drawings, fig. 8 is an elevation of the devices made use of by me, and fig. 9 is a diagram illustrative of the motions given to the respective parts. Fig. 11 is a sectional plan view below the line $x\ x$, fig. 8 ; and fig. 10 shows the sector made in two parts and the radius-arm as double.

"The engine-cylinder A, piston-rod B, cross-head C, crank C', crank-pin 3 and connecting-rod D are of ordinary construction, and the connecting-rod D has a short arm D' at right angles to the connecting-rod itself, so that such connecting-rod and short arm form a bent lever, and there is a radius-arm G, having a pivot or gudgeon 4, supported by an arm upon the frame of the engine, having an eye at the end, and at the moving end of this radius-arm G is a rocker F in the form of a bent lever, one end of which is united by a link L directly to the cross-head C, and the other end is united by a link E to the short arm D' of the connecting-rod ; hence in the movement of the parts the rocker F swings the radius-arm G upon its pivot 4, and the rocker F is swung upon its pivot 5 at the end of the arm G, in consequence of the short arm D' of the connecting-rod having a swinging movement as the crank-pin 3 describes a circle, and the end of the connecting-rod D rises and falls as it moves with such crank-pin ; hence the link H, pivoted at 6 upon the radius-arm G, receives a swinging motion up and down by the link 8 between the rocker F and said link H, and in addition to the up-and-down swinging motion given to the link H the pivot 6 thereof describes an arc of a circle, and as the radius-arm G is moved it carries the pivot 6 toward and from the valve-chest M, for giving to the valve the lap and lead required according to the direction in which the piston is moving. The valve-rod N is connected to the valve within the chest M, and such valve may be of any desired character, and at the other end of such valve-rod N is a sector O, pivoted at or near its center to such valve-rod N, and this valve-rod and sector can move back and forth in line with the valve-rod, the parts being supported by a pin in a horizontal slot, or, preferably, hung by a loose link K from the shaft Q, to which shaft a reversing-lever of any desired character is to be applied, and upon the end of the shaft Q is a crank-arm P and a link S to an arm upon the sector O. In this sector O is a slot or curved channel, the radius of which is the same length as the swinging link H, and in the slot of this sector is a block 10, to which the moving end of the swinging link H is pivoted. If now the parts stand in the position represented by the full lines in fig. 8, the valve receives its motion from the endwise movement given to the valve-rod N by the block 10 being moved up and down in the curved slot of the diagonally-placed sector O by the swinging link H, which link receives its motion as before described, and the proportion of the parts is such that the center of the block 10 is in line with the connection between the sector O and the valve-rod N when the crank passes the dead-center, and as the crank rises the block 10 is moved downwardly, and by the curvature of the sector O the valve receives its end motion, and when the crank C' passes the other dead-center the block 10 is moved upwardly to give the required motion to the valve in the other direction. In both instances the radius-arm G, as it swings, moves the pivot 6 of the link H toward and from the valve-chest, and thereby the proper movement is given to the valve in addition to the motion resulting from the block 10 moving in the sector O, so that the proper lap and lead to the valve is the result. When the shaft Q and crank-arm P are moved by the reversing-lever, the sector O is swung upon its connection to the valve-rod N, and it assumes the reverse diagonal position indicated by the dotted lines, so that the engine will run in the other direction ; but if the reversing-shaft Q and crank-arm P are moved to an intermediate position the sector O is not moved by the swinging of the link H, because the arc of the sector O corresponds to the arc described by the link H as a radius ; but the slight movement resulting from the pivot 6 being carried toward and from the valve-chest by the movement of the radius-arm G will by construction equal its lap and lead of the valve, but not be sufficient to admit steam even when the momentum of the locomotive may produce a continuance of the revolution of the crank C' and the shaft with which it is connected, after the reversing-gear has been moved to stop the engine."

THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

(*Continued from page 230.*)

CHAPTER III.—(*Continued.*)

ANGLES.

An *angle* is the amount of inclination of two lines to each other. Thus in fig. 40 the difference in the direction of the lines $E\ A\ B$ and $A\ C$ forms the angle $C\ A\ B$. This difference in their inclination is entirely independent of the length of the lines, and is measured on an arc of a circle drawn from the point A—called the *vertex* of the angle—where the two lines meet as a center. Thus suppose that any arc $f\ b\ c$ is drawn from A. The portion $b\ c$ of this arc between the lines $A\ B$ and $A\ C$ would then be a measure of the angle $C\ A\ B$. If from b a distance $b\ f = c\ b$ be laid off on $c\ b\ f$, and another line, $A\ D$, be drawn through A and f so as to form an angle with $C\ A$, then $b\ f$ would measure the angle $C\ A\ D$, and as $b\ f = b\ c$ the angles $B\ A\ C$ and $C\ A\ D$ are equal, and the angle $B\ A\ D$ is twice $B\ A\ C$ and $C\ A\ D$. If two angles are measured by arcs, the radii of the arcs must be of equal length. It is not important, however, what the length of the radii is, so that it is the same for both arcs. Thus the two angles might be measured by the arcs $c'\ b'$ and $b'\ f'$ as well as by $c\ b$ and $b\ f$; but we could not ascertain the extent or degree of the inclination of the lines if we measured the one angle with an arc $c\ b$ with a radius $c\ A$, and the other with an arc $b'\ f'$ with a drawn radius $c'\ A$, which is of a different length.

The standard or unit of measurement of angles is based upon the division of circles into 360 equal parts called *degrees*. In writing or printing these are indicated by a small circle, thus °, and 45 degrees is written 45°. It must be understood that all circles, without reference to their size, are supposed to have 360°, and that the angles formed by lines radiating from the center of a circle of any radius will include an equal number of degrees on the circumference of a circle of any other radius drawn from the same center. Thus, in fig. 41, the circles $a\ b\ c\ d\ e$, $a'\ b'\ c'\ d'\ e'$, and $a''\ b''\ c''\ d''\ e''$, drawn from the same center, A, are each divided into 360 equal parts or degrees. If a line, $A\ B$, is drawn through the center, A, and the 0 or *zero* point, as it is called, of the divisions, and another line, $A\ C$, through A and b, the 30th division, so that the two lines form an angle, $C\ A\ B$, with each other, they will include 30 of the divisions or degrees on each of the circles. The angle $C\ A\ B$ is therefore said to be an angle of 30°. If we draw another line, $A\ D$, through the 60th division so as to form an angle $D\ A\ B$ with $A\ B$, then $D\ A\ B$ will be an angle of 60°.*

If the circumference of any circle is divided into 360 equal parts, it will serve as a *protractor*, or instrument for measuring angles. Usually such instruments are made of a metal plate or card in the form of a half circle, which is divided in the same proportion, or into 180°, as shown by fig. 9.

Problem 9 (fig. 40). *To measure the number of degrees in an angle, as $B\ A\ C$, fig. 40.*

With a pair of compasses, take from fig. 41 a distance $A\ c$ = to the radius of the outside circle, which will serve as a protractor, and with this distance as a radius, from the vertex A, fig. 40, of the angle $B\ A\ C$ describe an arc $b\ c$. With a pair of dividers, take the distance from c to b, the points where the arc $b\ c$ intersects the lines $A\ B$ and $A\ C$. Then with the dividers carefully set one of its points on the 0 or zero point of the protractor at c, fig. 41, and measure on the circumference $c\ b$ the number of degrees included between the points of the dividers, which will be the number in $c\ b$, of fig. 40, and will be the measure of the angle $B\ A\ C$. We might draw an arc $c'\ b'$ with $A\ c'$, the radius of the intermediate circle in fig. 41, and then measure on its circumference from c' to b' and use it as the protractor, to get the number of degrees of the angle $C\ A\ B$, fig. 40 ; or we might take $A\ c''$, or the radius of the outer circle of the protractor, fig. 9, for the same purpose.

Problem 10 (fig. 42). *To lay off an angle of any number of degrees from a given line and vertex.*

If $A\ B$ is the given line, with a radius such as $A\ c$, fig 41, of any protractor, from the vertex A, fig. 40, of the proposed angle as a center, describe an arc $c\ b\ f$. Then from the circum-

* An angle of 90°, as $e\ A\ a$, figs. 40 and 41, is called a *right angle*, and is formed when one straight line, as $a\ A$, is drawn perpendicular to or square with another line, as $e\ A\ B$. An *acute angle* is one having less than 90°, as $B\ A\ C$ or $B\ A\ D$. An *obtuse angle* is one of more than 90°, as $e\ A\ D$ or $e\ A\ C$. An *oblique angle* is any angle not a right angle.

ference of the outside circle, in fig. 41, with a pair of dividers measure the proposed number of degrees from *o*—in this case 30°—and set them off from *c* to *b* on *c b f*, fig. 40. Through *A* and *b* draw the line *A C*. *B A C* will then be an angle of 30°. In the same way *B A D*, an angle of 60°, may be laid off.

If it is required to lay off an obtuse angle, as *e A D*, fig. 40, it is usually best to draw a perpendicular, as *a A*, through the vertex *A*, which will form a right angle *e A a* with *e A b*. Then

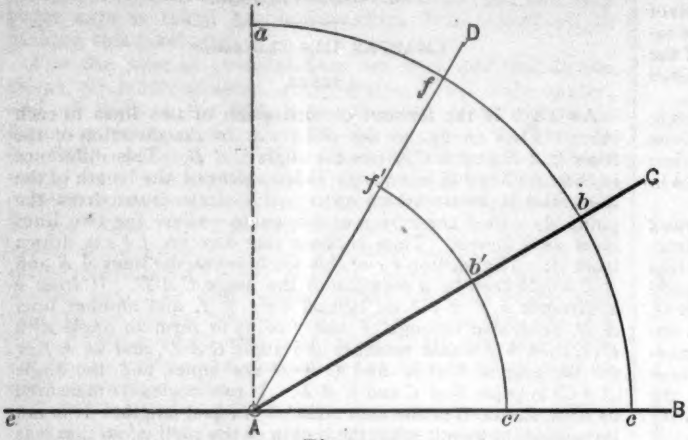


Fig. 40.

deduct 90 from the proposed number of degrees, and from the vertex *A* with the radius of a protractor draw an arc *a f*, and from the perpendicular *a A* lay off on the arc *a f* the difference between the number of degrees of the proposed angle and 90°, and draw *A D* through the vertex *A* and *f*; *e A D* will then be the required angle.

PROBLEM 11 (fig. 43). *To construct on a given line, D E, an angle equal to another angle, B A C, fig. 42.*

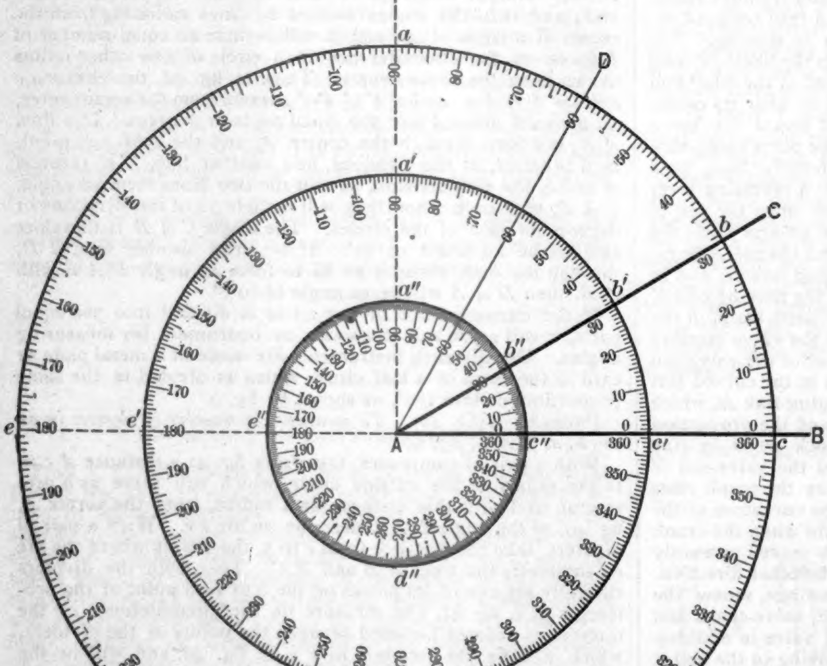
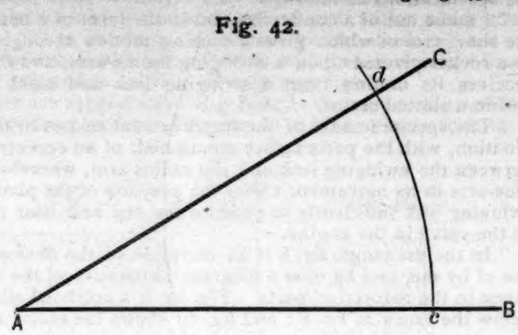


Fig. 41.

First Method.—Measure the angle *B A C* and then lay off another equal to it, as described in Problem 10.

Second Method.—From the vertex *A*, fig. 42, with any radius *A c* describe an arc *c d* intersecting *A B* and *A C*. With the same radius, and from *D*, fig. 43, the vertex of the proposed angle, draw an arc *g h*. Then, with a pair of compasses, take from fig. 42 the distance *c d* as a radius, and from *g*, fig. 43, as

Fig. 42.



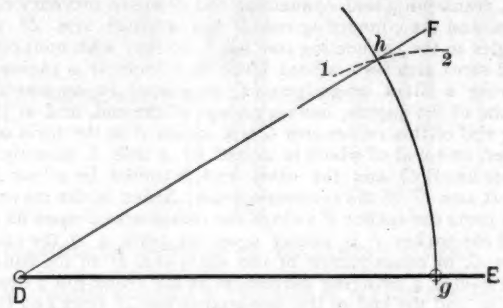


Fig. 43.

a center describe an arc 1 2 intersecting *h g* at *h*. Then draw *D F* through *h*, and the angle *F D F* will be equal to *B A C*.

PROBLEM 12 (fig. 44). *To bisect* or divide a given angle, B A C, into two equal parts.*

First Method.—From the vertex *A* of the angle with any radius draw an arc *D E*, cutting the lines *B A* and *C A* at *E* and *D*. From *D* and *E*, as centers, with any radius, draw arcs 1 1 and 2 2 intersecting each other at *F*. Through *A* and *F* draw the line *A F*, which will bisect the angle *B A C*.

Second Method.—With a pair of dividers subdivide the arc *D E* into two equal parts, and through *G*, the point of division, and the vertex *A* draw the line *A G*, and it will divide the angle *C A B* into the angles *C A G* and *G A B*, which will be equal.

PROBLEM 13 (fig. 45). *To bisect the angle between two straight lines, A B and C D, the vertex of which is inaccessible.*

If *A B* and *C D* be the two lines, draw two lines *f E* and *g E* parallel to *A B* and *C D*, so that the distance *a b* and *a' b'* between the parallel lines will be equal, and that *f E* and *g E* will intersect at *E*. By the preceding problem bisect the angle *f E g* by the line *h E*, which will also bisect the angle between the lines *A B* and *C D*.

PROBLEM 14 (fig. 46). *To trisect† a right angle.*

First Method.—If *D A E* is a right angle it may be divided into three equal parts by drawing an arc, *D F G E*, from the vertex *A* as a center with any radius, and then dividing this arc with a pair of dividers into three equal parts, and drawing lines *A F* and *A G* through the points of division. The angles *D A F*, *F A G*, and *G A E* will then all be equal.

Second Method.—Draw the arc *D F G E* as before. Then with the same radius, and from *E* as a center, draw the arc 1 1 intersecting *D F G E* at *F*, and from *D* as a center draw 2 2. Through the points of intersection *F* and *G* draw lines *A F* and

* To *bisect* means to divide into two equal parts.
† To *trisect* means to divide into three equal parts.

A G, and they will divide the angle *D A E* into three equal parts.

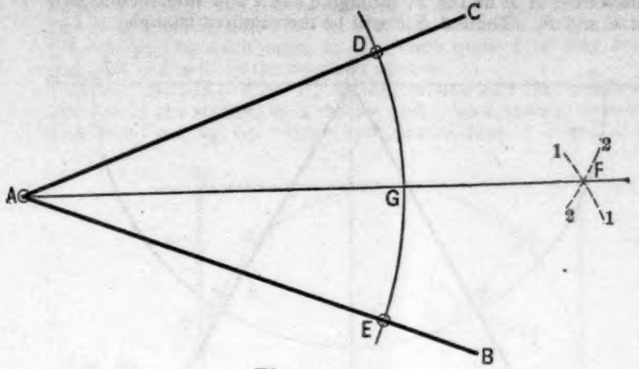


Fig. 44.

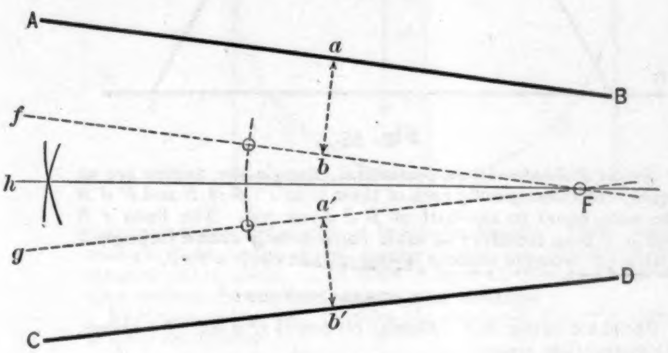
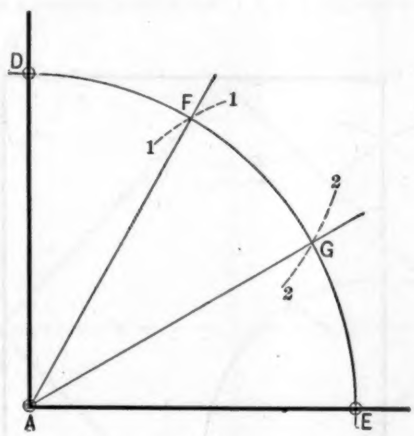


Fig. 45.

Fig. 46.



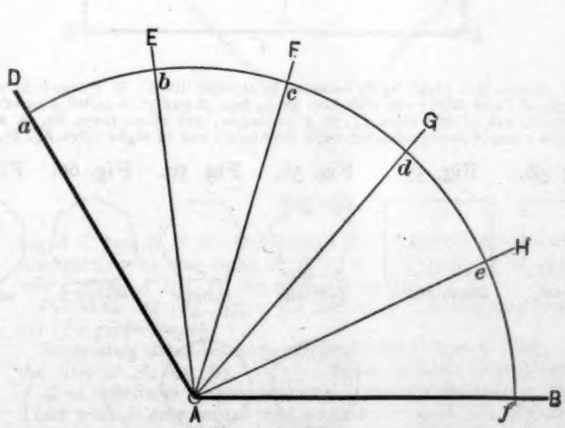


Fig. 46a.

PROBLEM 15 (fig. 46 *a*). *To divide any angle into any number of equal parts.*

Let *D A B*, fig. 46 *a*, be an angle to be divided into, say, five equal parts. From the vertex *A*, as a center, and with any radius draw an arc *a b c d e f*. With a pair of dividers, by repeated trial, divide this arc into the required number of equal parts—in this case five—and through the points of division, *b c d e*, draw the lines *A E*, *A F*, *A G* and *A H*. These lines will then enclose equal angles.

TRIANGLES.*

PROBLEM 16 (fig. 50). *Having the length of the three sides to construct a triangle.*

Let the length of these sides be $2\frac{3}{4}$", 4" and $5\frac{1}{4}$". Lay down one of these sides, *A B*, fig. 50, preferably the longest. Then, with the compasses, take the length of one of the other sides, and from *B*, the extremity of *A B*, describe an arc 1 1, and with the length of the third side and *A* as a center draw another

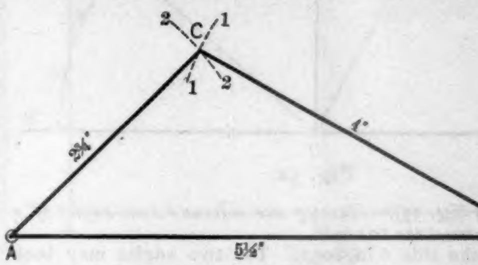


Fig. 50.

arc 2 2, intersecting the first one at *C*. Draw lines *A C* and *B C* through *A* and *C* and *B* and *C*, which will complete the triangle.

PROBLEM 17 (fig. 51). *Having the length of two sides and the included† angle of a triangle, to construct the triangle.*

Supposing that the one side is 5 in. and the other 3 in. long, and the angle between them is 35°. Draw *A B*, fig. 51, equal to 5 in. Then, with a protractor, from *A* lay off an angle $D\ A\ B = 35°$, and draw *A D* of indefinite length. From *A*

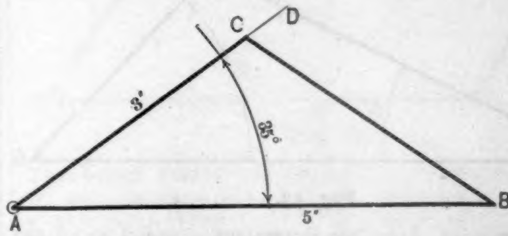


Fig. 51.

make $A\ C = 3$ in., and draw *C B*, which will complete the triangle.

PROBLEM 18 (fig. 52). *Having two angles of a triangle, to ascertain the third angle.*

First Method.—If the two angles are given in degrees, add them together and deduct the sum from 180°; the remainder will be the third angle.

* A plane triangle (the only kind which will be considered here) is a figure bounded or enclosed by three straight lines, and which has three angles, as *A B C*, figs 47, 48 and 49. If one of the angles, *A C B*, fig. 47, is a right angle, the figure is called a *right-angled triangle*. The longest side, *A B*, which is opposite the right angle, is called the *hypotheneuse*; the lower side, *A C*, the *base*; and the other side, *B C*, the *perpendicular*.

If all the sides of a triangle are of equal length, as in fig. 48, it is called an *equilateral triangle*.

Two triangles or other figures are said to be *similar* to each other when they are of the same shape and have the same proportions, as shown by figs. 48 and 49, which represent similar triangles.

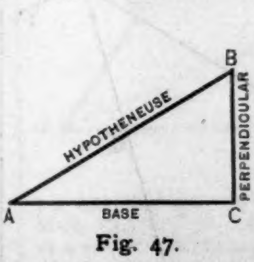


Fig. 47.

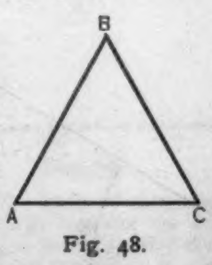


Fig. 48.

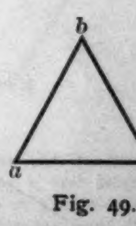


Fig. 49.

By the *area* of a figure we mean the amount of surface included within its outside lines. Thus a field is said to contain so many acres, or it has an *area* of so many acres, or a board has so many square feet of *area*.

Triangles and other figures are said to be *equal* when they have the same area—that is, when they contain precisely the same *space*. A figure may be *equal* to another without being similar in shape; thus a triangle and a square may have the same area and therefore be *equal*, although they are not of the same shape.

If the angles of any triangle are added together their sum will always be equal to two right angles.

† By the *included* angle is meant the angle contained between the two sides.

Second Method.—If from a line $A\ B$, fig. 52, a perpendicular $C\ D$ is drawn, then the two angles $C\ D\ B$ and $C\ D\ A$ will both be right angles, and therefore equal to the sum of the angles of a triangle. If the angles which are given are 40° and 80°, lay off from D as a vertex an angle $B\ D\ E = 40°$ and $E\ D\ F = 80°$; then $F\ D\ A$ will = the third angle of the triangle.

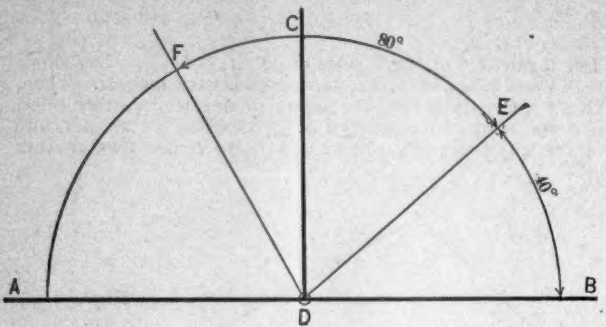


Fig. 52.

PROBLEM 19 (fig. 53). *Having one side and two angles of a triangle, to construct the triangle.*

Let $A\ B$ be the side 6 in. long. The two angles may both be adjacent to $A\ B$, as $C\ A\ B$ and $C\ B\ A$, or one of them may be adjacent and the other, $A\ C\ B$, may be opposite to the side which is given. In the latter case ascertain the third angle by the preceding problem. We will then have two angles and their included side.

Draw a straight line, $A\ B$, fig. 53, equal to the length of the given side = 6 in. From the extremities A and B lay off the angles $D\ A\ B$ and $E\ B\ A$ adjacent to $A\ B$, and extend $A\ D$ and $B\ E$ until they intersect at C; then $A\ C\ B$ will be the triangle required.

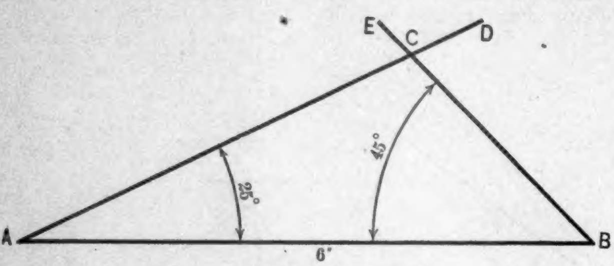


Fig. 53.

PROBLEM 20 (fig. 54). *Having the length of two sides of a triangle, and an angle opposite to one of them, to construct the triangle.*

Supposing that the lengths of the two sides are $4\frac{1}{2}$" and $3\frac{1}{4}$" respectively, and that the angle opposite the shorter side is 30°. Draw an indefinite line $A\ B$, and from its extremity A, as a vertex, lay off an angle $B\ A\ C = 30°$, the given angle, and extend $A\ C$. From A lay off a distance $A\ B =$ to the longer side, or $4\frac{1}{2}$". From B as a center, with the length of the shorter side as a radius, describe an arc 1 1 to intersect $A\ C$, and draw $B\ C$; then will $A\ B\ C$ be the required triangle.

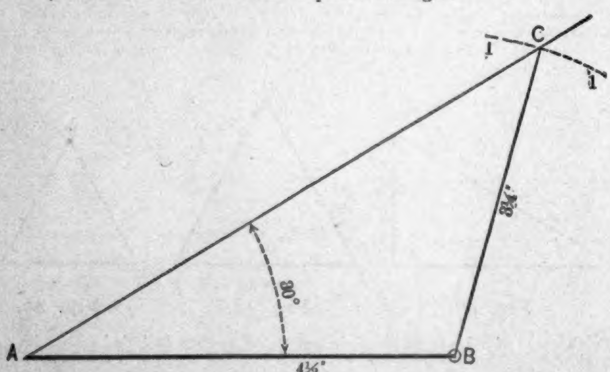


Fig. 54.

PROBLEM 21 (fig. 55). *To construct an equilateral triangle, the vertical height being given.*

First Method.—Let $A\ B$ be the vertical height. Through A and B draw the indefinite lines $C\ D$ and $G\ H$ perpendicular to $A\ B$. From A as a center with any radius draw the semicircle $a\ b\ c\ d$, and from a and d as centers and the same radius describe arcs 1 1 and 2 2 intersecting $a\ b\ c\ d$ at b and c. From A draw lines $A\ E$ and $A\ F$, through b and c and intersecting $G\ H$ at E and F. Then $A\ E\ F$ will be the required triangle.

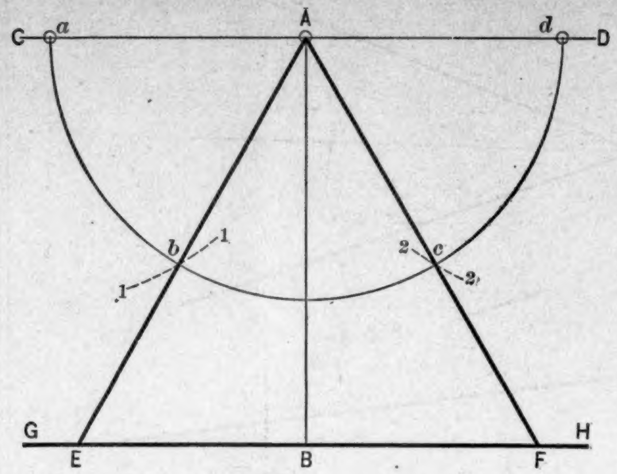


Fig. 55.

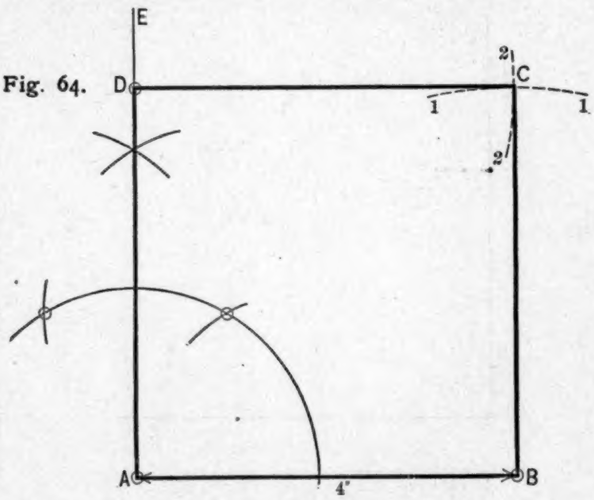
Second Method.—In an equilateral triangle the angles are all equal, and consequently each of them is 60°. $E\ A\ B$ and $F\ A\ B$ are each equal to one-half of $B\ A\ F$, or 30°. The lines $A\ E$ and $A\ F$ may therefore be most conveniently drawn through A with a 30° triangle without laying off the circle $a\ b\ c\ d$.

SQUARES AND OTHER POLYGONS.*

PROBLEM 22 (fig. 64). *Having the length of a side of a square, to construct the square.*

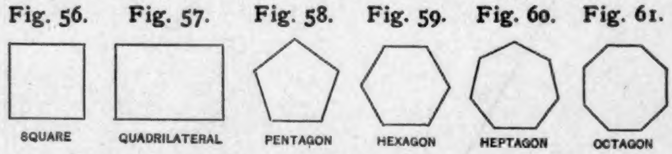
First Method.—Let $A\ B$ be the side of a square = 4 in.

Fig. 64.



* A *polygon* is a plane figure bounded by straight lines. A *triangle* is a polygon of three sides; one with four sides, figs. 56 and 57, is called a *quadrilateral;* one of five sides, fig. 58, a *pentagon;* one of six sides, fig. 59, a *hexagon;* one of seven sides, fig. 60, a *heptagon;* one of eight sides, fig. 61,

Fig. 56. Fig. 57. Fig. 58. Fig. 59. Fig. 60. Fig. 61.



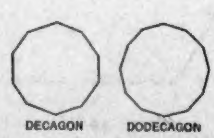


Fig. 62. Fig. 63.

an *octagon;* one of 10 sides, fig. 62, a *decagon;* one of 12 sides, fig. 63, a *dodecagon.*

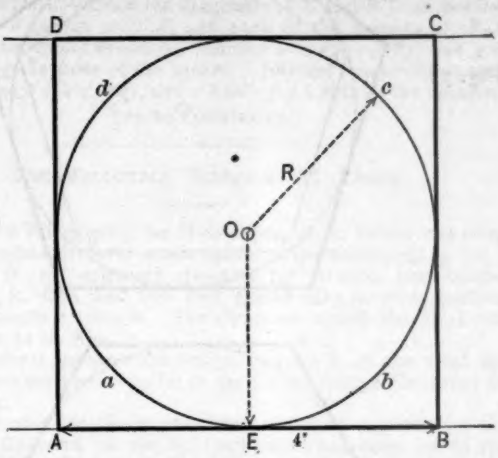
A *square*, fig. 56, is a four-sided quadrilateral whose sides are all equal, and its angles are all right angles.

A *rectangle*, fig. 51, is a four-sided figure whose angles are all right angles.

From one extremity, A, of $A\ B$, erect a perpendicular $A\ E$ to $A\ B$, by the sixth or seventh methods described in Problem 8. From A lay off on $A\ E$ a distance $A\ D = A\ B$. From B and D as centers, and $A\ B$ as a radius, describe arcs 1 1 and 2 2, intersecting each other at C. Then draw $D\ C$ and $B\ C$, and $A\ B\ C\ D$ will be the required square.

Second Method.—With R, fig. 65, = one-half the length of the side of the square, as a radius, and O as a center, describe a circle $a\ b\ c\ d$, fig. 65. Draw two parallel lines, $A\ B$ and $D\ C$,

Fig. 65.



tangent to the circle and of indefinite length. Then, with a triangle, draw $A\ D$ and $B\ C$ perpendicular to $A\ B$ and $D\ C$ and tangent to the circle. The lines $A\ B$, $B\ C$, $C\ D$, and $B\ E$ will then enclose the required square.

PROBLEM 23 (fig. 66). *Having the diagonal* $A\ C$ of a square, to draw the square.*

Bisect $A\ C$ at O. Erect a perpendicular to $A\ C$ which will pass through O. Then with $O\ A$ = one-half of $A\ C$ as a radius, and O as a center, describe arcs 1 1, 2 2, 3 3 and 4 4, intersect-

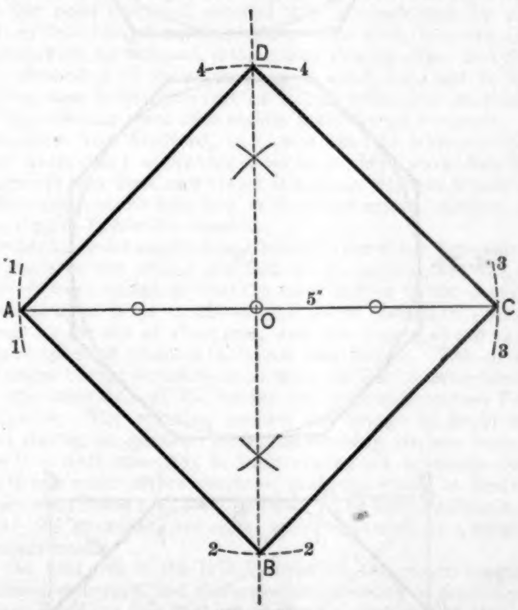


Fig. 66.

ing $A\ C$ and $B\ D$ at $A\ B\ C$ and D. Connect these points of intersection by the lines $A\ B$, $B\ C$, $C\ D$ and $D\ A$, and they will enclose $A\ B\ C\ D$, the required square.

PROBLEM 24 (fig. 67). *To construct a rectangle whose sides are of a given length.*

Supposing the sides to be respectively 5" and 3" long. Draw the line $A\ B$, fig. 67, = 5". From A erect a perpendicular $A\ E$ of indefinite length, and lay off on it a distance $A\ D$ = 3". Then with D as a center and a radius = $A\ B$ = 5" describe an arc 2 2, and with B as a center and a radius = $A\ D$ = 3" describe the arc 1 1 intersecting 2 2 at C. Draw $B\ C$ and $C\ D$, and $A\ B\ D\ C$ will be the required rectangle.

* A *diagonal* is a straight line from one angle to another, not adjacent, of a figure of four or more sides, and dividing it into two parts. $A\ C$, fig. 66, is the diagonal of the square $A\ B\ C\ D$.

PROBLEM 25 (fig. 68). *To construct a parallelogram* whose angles are not right angles, of which the sides and one of the angles are given.*

Let two of the opposite sides = $A\ B$, fig. 68, = $4\frac{1}{2}$" and the other two sides = 3", and two of the angles = 55°. Draw $A\ B$ = $4\frac{1}{2}$". From A, by the method described in Problem 11, lay off an angle $D\ A\ B$ = 55°, and draw $A\ E$ of indefinite length.

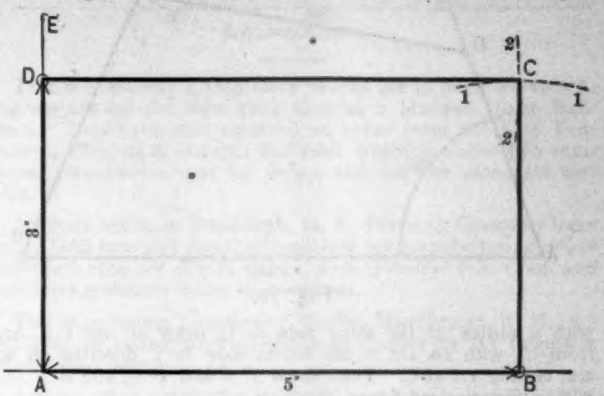


Fig. 67.

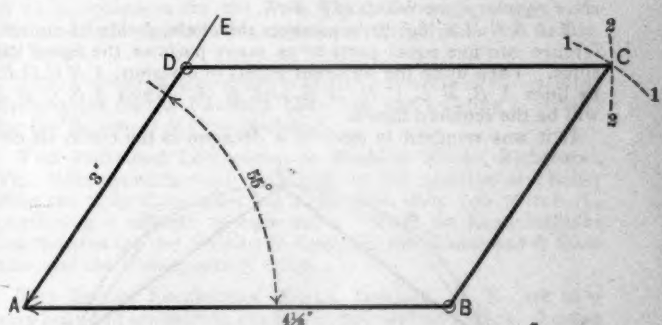


Fig. 68.

Then lay off from A a distance $A\ D$ = 3". From D as a center, and a radius = $A\ B$ = $4\frac{1}{2}$", draw the arc 2 2, and from B as a center and a radius = $A\ D$ = 3" draw the arc 1 1, intersecting 2 2 at C. Draw $B\ C$ and $D\ C$, and then $A\ B\ C\ D$ will be the required parallelogram.

PROBLEM 26 (fig. 69). *To construct a parallelogram whose angles are not right angles, of which the diagonal and its sides are given.*

If the sides are respectively $4\frac{1}{2}$" and 3" long and the diagonal $6\frac{11}{16}$", lay off one of the sides $A\ B$ = $4\frac{1}{2}$". With A as a center and the length of the diagonal draw an arc 1 1. With B as a center and a radius = the length of the shorter sides draw

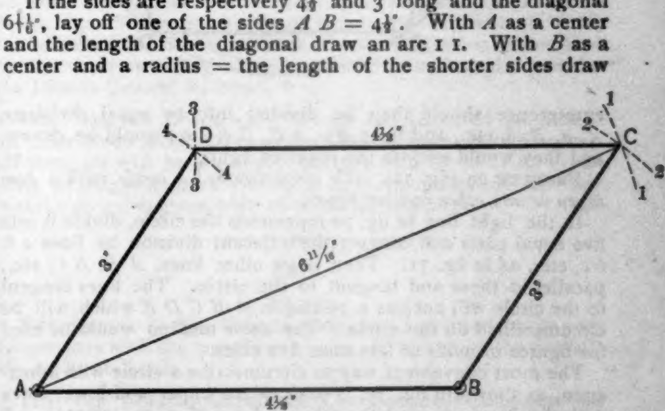


Fig. 69.

2 2, intersecting 1 1 at C. From C as a center with the length of the long side as a radius describe the arc 3 3, and from A as a center with the length of the shorter side = 3" as a radius describe the arc 4 4, intersecting 3 3 at D. Draw the lines $B\ C$, $C\ D$, $D\ A$, and $A\ C$; $A\ B\ C\ D$ will then be the required parallelogram and $A\ C$ the diagonal.

PROBLEM 27 (fig. 70). *To draw a four-sided figure, none of whose sides are parallel, the length of its sides and one of the angles being given.*

* A *parallelogram* is a four-sided figure whose opposite sides are parallel. $A\ B\ C\ D$, fig. 68, is a *parallelogram*.

If the sides are $5\frac{1}{4}''$, $2\frac{1}{4}''$, $3\frac{1}{4}''$, and $3''$ long, and the angle contained between the first and second sides is 70° ; then draw $A\ B = 5\frac{1}{4}''$. From A lay off an angle $B\ A\ D = 70°$ and draw $A\ E$ of indefinite length. Make $A\ D = 2\frac{1}{4}''$, and from D as a center

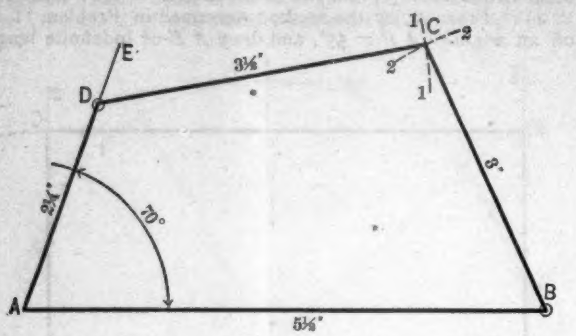


Fig. 70.

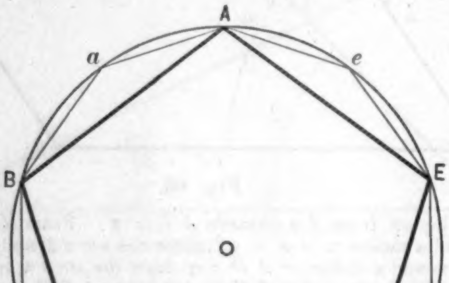
with a radius = the third side = $3\frac{1}{4}''$ draw an arc 1 1, and from B with an arc = the fourth side = $3''$ describe an arc 2 2, cutting 1 1 at C. Then draw $B\ C$ and $D\ C$, and $A\ B\ D\ C$ will be the required figure.

PROBLEM 28 (fig. 71). *To inscribe* a regular† pentagon or other regular figure inside of a circle.*

If $A\ B\ C\ D\ E$, fig. 71, represents the circle, divide its circumference into five equal parts or as many parts as the figure has sides. Then unite the adjacent points of division, $A\ B\ C\ D\ E$, by lines $A\ B$, $B\ C$, $C\ D$, $D\ E$, and $E\ A$. Then $A\ B\ C\ D\ E$ will be the required figure.

If it was required to inscribe a decagon in the circle, its cir-

Fig. 71.



cumference should then be divided into 10 equal divisions, A, a, B, b, etc., and lines $A\ a$, $a\ B$, $B\ b$, etc., would be drawn, and they would enclose the required figure.

PROBLEM 29 (fig. 72). *To circumscribe‡ a circle with a pentagon or any other regular figure.*

If the light line in fig. 72 represents the circle, divide it into five equal parts and connect the adjacent division by lines $a\ b$, $b\ c$, etc., as in fig. 71. Then draw other lines, $A\ B$, $B\ C$, etc., parallel to these and tangent to the circle. The lines tangent to the circle will enclose a pentagon $A\ B\ C\ D\ E$ which will be circumscribed on the circle. The same method would be used for figures of more or less than five sides.

The most convenient way to circumscribe a circle with a hexagon, as shown in fig. 73, is to draw the upper and lower sides with the T square, and the other sides with a 30° triangle. $B\ C$ and $F\ E$ can be drawn with the triangle in the position shown at A, in fig. 21, and $B\ A$ and $D\ E$ with it in the position shown by the dotted lines D in the same figure. If two of the sides of the hexagon are vertical, they may be drawn by the edge $b\ c$ of the triangle in the position shown at B, fig. 21, and two of the other sides along the edge $b\ e$. The remaining sides of the hexagon can then be drawn by reversing the triangle. This way of drawing hexagons has a frequent practical application in representing six-sided nuts.

* To *inscribe* means to draw within. Thus in fig. 71 the pentagon *A B C D E* is *inscribed* within the dotted circle outside of it.

† A *regular* pentagon or regular figure is one whose sides are of equal length.

‡ To *circumscribe* means to draw around.

Octagons, fig. 74, may also be drawn in a similar way by using the T-square and 45° triangle, as shown at C, fig. 21 ; the edge

Fig. 72.

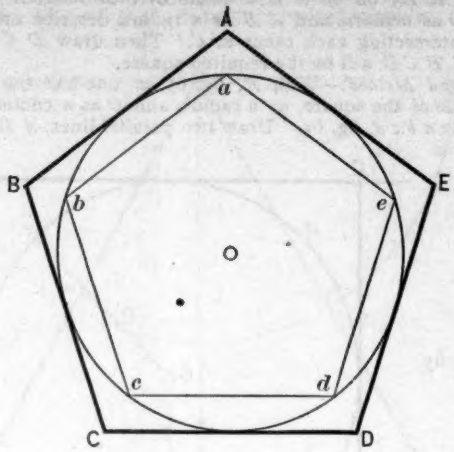


Fig. 73.

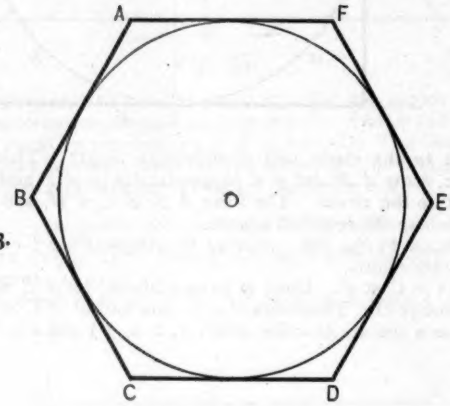


Fig. 74.

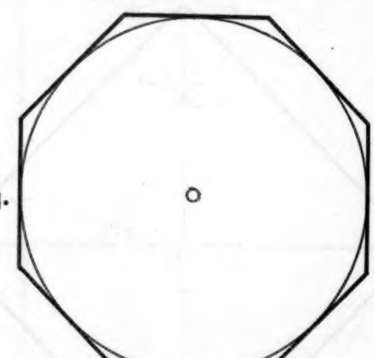
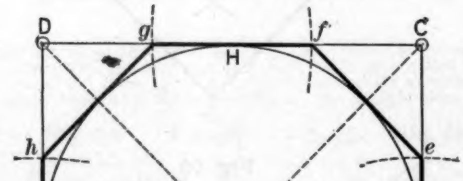


Fig. 75.



$a\ b$ serving to draw the perpendicular and $a\ c$ for the diagonal sides.

PROBLEM 30 (fig. 75). *To inscribe a regular octagon in a given square.*

First Method.—If $A\ B\ C\ D$ is the given square, draw the diagonals $A\ C$ and $B\ D$ intersecting one another at E. From E as a center and with a radius $E\ F$, draw a circle $F\ G\ H\ I$ inside of $A\ B\ C\ D$ and touching the four sides of the square. Then with a 45° triangle draw the sides $a\ b$, $c\ d$, $e\ f$, and $g\ h$ tangent to the circle $F\ G\ H\ I$; $a\ b\ c\ d\ e\ f\ g\ h$ will be the completed octagon.

Second Method.—Draw the diagonals $A\ C$ and $B\ D$ as before. Then with a radius $= B\ E$, and each of the corners A, B, C and D of the square as centers describe arcs $a\ b$, $c\ d$, $e\ f$, and $g\ h$, intersecting the sides of the square. Join the points of intersection by lines $a\ b$, $c\ d$, etc., and $a\ b\ c\ d\ e\ f\ g\ h$ will be the octagon.

(TO BE CONTINUED.)

The Merchants' Bridge at St. Louis.

THIS new bridge over the Mississippi, at St. Louis, just completed, consists of three main spans, respectively, 521.5, 523.5 and 521.5 ft., six approach spans of 125 ft. each, four braced piers of 25 ft. each and two pier spaces of 3 ft. each, making the total length 2,422.5 ft. The clearance above the St. Louis directrix is 54 ft. 3 in.

The contract for the main bridge and 425 ft. of the steel approaches on each end was let to the Union Bridge Company of New York.

The contract for the double-track elevated structure of the Terminal Railroad, on the St. Louis side, has been let to the Phœnix Bridge Company. The terminal tracks have been laid from the Water Works to Biddle Street, and it is expected that the elevated structure will be completed and all tracks laid and connections made with the St. Louis & San Francisco Railroad and the Union Depot tracks by May 1.

The general plan of the bridge and its approaches and most of the details that were recommended by the engineers, Messrs. George S. Morison and E. L. Corthell, have been followed in the actual construction of the work. Examinations made of the rock during the building of the piers, when all material overlying it had been removed, showed that in every case the piers rested on firm hard limestone rock. The rock, in every case, was leveled off, or stepped, for the iron cutting edge, and thoroughly cleaned of all loose shale, clay, sand, etc., and at least two holes were drilled five feet into it, to determine its character. The caissons were then solidly packed with concrete.

Limestone from Bedford, Ind., was used to within 3 ft. of the low water-line; above this level to the high water-line Missouri granite was used, and above this again Bedford limestone. The dimension stone was laid in Portland cement mortar, and the backing in Louisville cement.

In order to make a less abrupt break in the grade between the level grade of the bridge and that of the approaches, the two river piers were raised so that the clear height in the center of the central span is 52 ft. above high water instead of 50 ft., as required by the act of Congress, and the height at the end of the shore spans is about 4 in. below this height. This gives a much better bridge for navigation than the law contemplated.

On the west end of the bridge the approach crosses Ferry Street twice. The crossing nearest the bridge is made by a viaduct resting on cylinder piers, the crossing furthest from the bridge is a deck-span 125 ft. long resting on masonry piers. There is one other street overhead crossing, which is made by masonry abutments and steel girders. The intermediate space between the structures are either solid earthwork or a substantial timber trestle.

On the east end of the bridge, between the 425-ft. length of permanent structure and the overhead crossing at the Chicago & Alton, Bee Line and Wabash Railroads, and east of this last-named structure to the earth embankment, the intermediate spaces are filled with a wooden trestle. The bridge at the crossing of these three railroads is made by two masonry abutments on which rest a 175-ft. span and a 40-ft. steel girder. The entire bridge and approaches is built for double track.

The style of the three spans of the main bridge is a double intersection pin-connected truss with horizontal bottom chord and a curved top chord. The entire structure is of steel, except pedestals and ornamental parts, which are of cast iron, and nuts, swivels and clevises, which are of wrought iron.

The steel was required to stand an ultimate tensile strain in the sample bar of from 63,000 to 70,000 lbs. per square inch, with an elastic limit of not less than 38,000 lbs. Finished bars, selected by the engineer, were subjected to a breaking test, the requirements being an elongation of 10 per cent. before breaking. The structures are so proportioned that under all possible conditions the material cannot be subjected to injurious strains.

¶ Connections with the various railroads are made on the St. Louis side of the river by the Terminal Railroad, and on the east side by the Venice & Carondelet Belt Railroad.

Manufactures.

Locomotives.

THE Schenectady Locomotive Works are to build 40 switching engines for the New York Central & Hudson River Railroad. They have also received an order from the East Tennessee, Virginia & Georgia Railroad, which includes two compound locomotives, one for freight and one for passenger service.

AT their works in Pittsburgh, H. K. Porter & Company have lately built two very small locomotives for manufacturing establishments they are of 2 ft. gauge, with cylinders 6 × 12 in. and our driving-wheels 23 in. in diameter.

THE Manchester Locomotive Works, Manchester, N. H., are building 20 locomotives of different classes for the Boston & Maine Railroad.

AMONG other orders the Baldwin Locomotive Works, Philadelphia, have received one for seven ten-wheel engines with 20 × 24-in. cylinders for the New York, Pennsylvania & Ohio Railroad, and eight shifting engines for the Merchants' Bridge, St. Louis.

THE Pittsburgh Locomotive Works have recently completed five engines for the Vandalia Line, and are building a number for the Baltimore & Ohio Railroad.

THE Richmond Locomotive & Machine Works, Richmond, Va., have recently been enlarged by the addition of a boiler shop 185 × 92 ft. in size, and a machine shop 100 × 106 ft., containing a number of new tools. Work on hand includes locomotives for the Atlantic & Danville, the Richmond & Danville and the Chesapeake & Ohio.

THE Brooks Locomotive Works, Dunkirk, N. Y., are now very busy and are turning out four or five engines a week. Among recent deliveries are five passenger engines with 18 × 24-in. cylinders and two six-wheel switching engines with 18 × 24-in. cylinders for the Baltimore & Ohio Southwestern; 10 passenger engines with 18 × 24-in. cylinders for the Chicago & Grand Trunk; 10 mogul freight engines, with 18 × 24-in. cylinders, for the New York, Chicago & St. Louis. Orders now on hand include 10 heavy 10-wheel passenger engines, with 18½ × 24-in. cylinders, for the Cleveland, Cincinnati, Chicago & St. Louis; 10 passenger engines of the 10-wheel type, with 18 × 24-in. cylinders, for the Wisconsin Central; 25 freight engines of the 10-wheel pattern, with 17 × 24-in. cylinders, for the Lake Shore & Michigan Southern; 25 mogul freight engines, with 19 × 26-in. cylinders, for the New York Central & Hudson River, and 15 six-wheel switching engines, with 18 × 24-in. cylinders, for the Illinois Central Railroad.

THE Baldwin Locomotive Works has delivered the first of an order of 40 locomotives to the Central Railroad of Georgia. Of these six will be passenger engines with 17 × 24 in. cylinders, 30 freight engines with 19 × 24 in. cylinders and four six-wheel shifting engines with 18 × 22 in. cylinders.

Cars.

THE Denver & Rio Grande Company has fitted up its passenger cars with the new Scarritt seat, furnished by the Scarritt Works in St. Louis.

THE Van Dorston Cushioned Car Coupling Company has equipped a number of new cars for the Philadelphia & Reading Railroad with the Van Dorston cushioned coupler.

THE Atlanta & West Point shops, Atlanta, Ga., have recently turned out two very handsome passenger cars. The finish is complete, and their fine appearance is claimed to be largely due to the use of the Valentine varnishes.

THE Scarritt Furniture Company, St. Louis, has recently added a new five-story building to its works, making them probably the largest car-seat factory in operation. A number of Scarritt reclining chairs have recently been ordered by the Kansas City, Fort Scott & Memphis Railroad.

THE Lake Shore & Michigan Southern has received nearly all the 3,300 freight cars, the contracts for which were placed at

intervals last fall. The new equipment consists of 1,000 drop-bottom gondola, 1,500 box, 250 hay, and 500 platform cars. The orders for these cars were placed as follows: Wells & French Company, 1,200; Peninsular Car Company, 1,000; Buffalo Car Manufacturing Company, 100; Indianapolis Car Manufacturing Company, 200; Lafayette Car Works, 400; Barney & Smith Manufacturing Company, 400. In addition to the freight cars the Barney & Smith Manufacturing Company is finishing an order of 10 passenger, 1 dining and 5 baggage cars for the road.

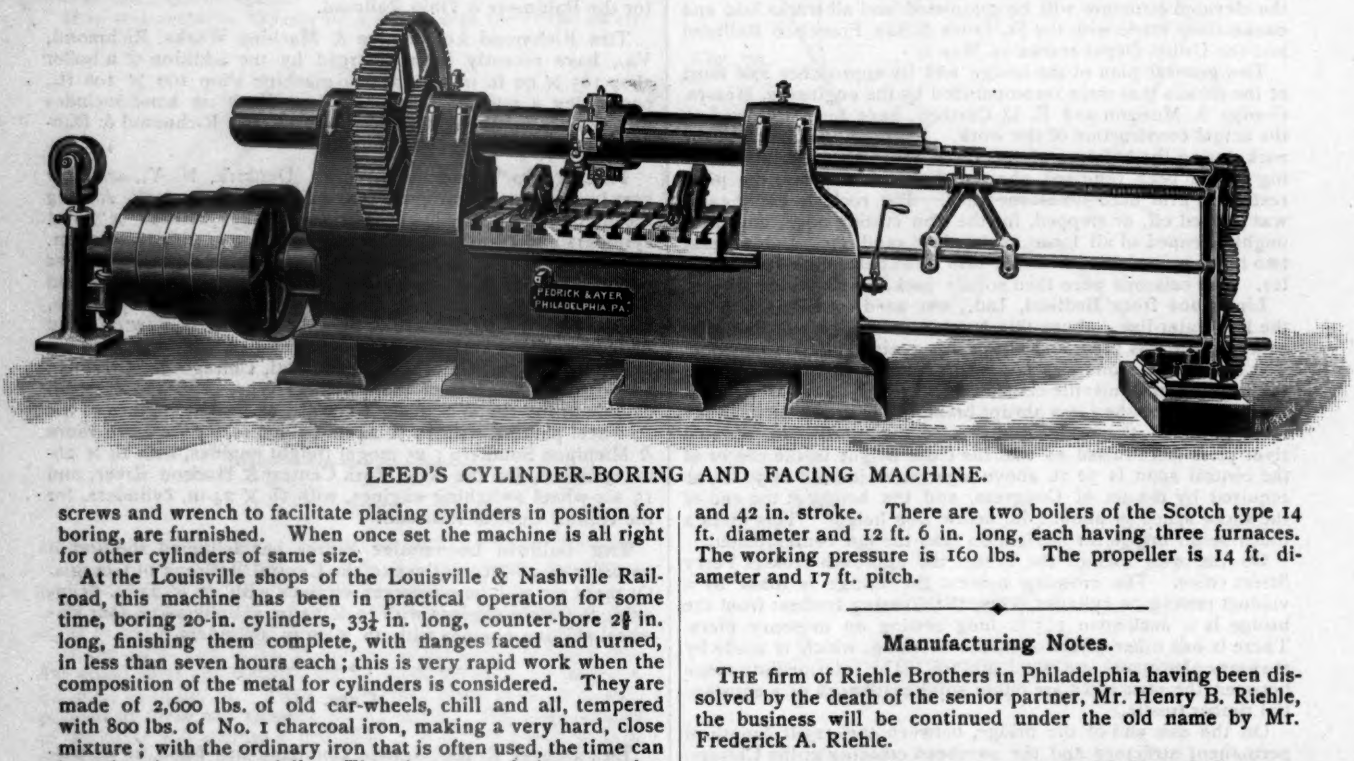
Leed's Cylinder-Boring and Facing Machine.

THE accompanying illustration shows a machine intended to bore and face locomotive cylinders rapidly and accurately. The bed, housings, and platen are very heavy, and an 8-in. bar is used driven by powerful gears 4½ in. and 5-in. face, back-geared 36 to 1 and driven by a 5-in. belt on cones, the largest of which is 30 in. in diameter and the smallest 18 in. in diameter, with five changes. The feed is made changeable by placing change gears similar to lathes for cutting screws. The distance between the bearings for bar to revolve in is 4 ft. 6 in., but can be made to meet any requirements.

The table or platen is 36 in. long, with suitable T-slots for securing the work. From top of platen to center of bar is 17½ in. At the end of the machine, forming a part of the cone-shaft support, is a sheave to take the weight of the bar when it is drawn out to place the cylinder on the platen. The table or platen has a sufficient amount of adjustment and is operated by a screw 2½ in. in diameter, by a crank from either front or rear end of the machine. When desired four adjustable saddles to receive the cylinders, which have movable parts operated by screws and wrench to facilitate placing cylinders in position for boring, are furnished. When once set the machine is all right for other cylinders of same size.

At the Louisville shops of the Louisville & Nashville Railroad, this machine has been in practical operation for some time, boring 20-in. cylinders, 33½ in. long, counter-bore 2⅝ in. long, finishing them complete, with flanges faced and turned, in less than seven hours each; this is very rapid work when the composition of the metal for cylinders is considered. They are made of 2,600 lbs. of old car-wheels, chill and all, tempered with 800 lbs. of No. 1 charcoal iron, making a very hard, close mixture; with the ordinary iron that is often used, the time can be reduced very materially. They do not use facing arms, but place a side tool in the regular cutter-head and face off with that, doing satisfactory work.

This machine was designed by Mr. P. Leeds, of the Louisville & Nashville Railroad, and is made by Pedrick & Ayer, of Philadelphia.



LEED'S CYLINDER-BORING AND FACING MACHINE.

Marine Engineering.

THE New York, Lake Erie & Western Railroad Company has let a contract to Neafie & Levy, of Philadelphia, for a new ferry-boat to run between New York and Jersey City. The boat will be 230 ft. long, 38 ft. beam, 62 ft. wide over the guards, and 16 ft. depth of hold. It will be a double-screw boat with a propeller at each end, much on the plan of the *Bergen* of the Hoboken ferry. The engines will be of the compound type.

IN their yards at Bay City, Mich., Wheeler & Company are building a car ferry-boat for the Canadian Pacific Company, to run between Detroit and Windsor. The boat is of steel, 295 ft. long, 41 ft. beam, 17 ft. deep and will draw 11 ft. 9 in. with a deck-load of 640 tons. She is a side-wheeler, with a separate engine to each wheel, the engines having cylinders 50 in. in diameter and 114 in. stroke; the wheels are 28 ft. in diameter. There are four boilers, each 13 ft. 3 in. in diameter and 14 ft. long; the working pressure will be 85 lbs.

THE new steel steamboat *Plymouth* for the Old Colony Steamboat Company was launched at the Roach Yard at Chester, Pa., April 3. The *Plymouth* is 366 ft. over all, 350 ft. molded length, 50 ft. beam, 85 ft. over guards and 19 ft. depth of hold. She will ply between New York and Fall River, and, like the *Puritan* and *Pilgrim* of the same fleet, is constructed on the double-hull bracket plate and longitudinal system, giving her seven water-tight bulkheads and 50 water-tight compartments. Instead of a compound beam-engine like the *Pilgrim*, the *Plymouth* will have four-cylinder triple-expansion engines connected directly to the main shaft.

THE Minnesota Mining Company has been organized at Duluth Minn., with $600,000 capita lto develop a tract of iron land about four miles from Vermilion Lake and near the line of the Duluth & Iron Range Railroad. The tract includes 960 acres, and is known to be very rich in iron ore.

THE Globe Iron Works in Cleveland, O., has completed four steel steamers for the Minnesota Steamship Company; they are intended to carry iron ore from Lake Superior, and have a capacity of 2,800 tons. Each of these ships is 311 ft. long over all, 40 ft. beam and 24 ft. 6 in. deep. The engines are triple-expansion, with cylinders 24 in., 38 in. and 61 in. in diameter and 42 in. stroke. There are two boilers of the Scotch type 14 ft. diameter and 12 ft. 6 in. long, each having three furnaces. The working pressure is 160 lbs. The propeller is 14 ft. diameter and 17 ft. pitch.

Manufacturing Notes.

THE firm of Riehle Brothers in Philadelphia having been dissolved by the death of the senior partner, Mr. Henry B. Riehle, the business will be continued under the old name by Mr. Frederick A. Riehle.

IN accordance with instructions, the R. W. Hunt & Company Inspection Bureau recently inspected 10,000 car wheels made by A. Whitney & Sons for the Savannah, Florida & Western Railroad. For size each wheel was measured around the tread by a brass tape divided into spaces of ⅛ in. each. The record shows that 4,325 wheels were of exactly the same circumference; 4,365 were but ⅛ in. less; 881 were but ⅛ in. over, while 429 were varied over ⅛ in. either way. That is, the extreme variation in 8,690 of these wheels was $\frac{1}{24}$ in. in diameter, and in 881 it was only $\frac{1}{12}$ in. For roundness the wheels were tested by a true ring resting on the cone of the wheel, and none was found with a variation of more than $\frac{1}{32}$ in. at any point. For strength, 105 of the wheels were broken under the drop test by a weight of 140 lbs. falling 12 ft. The specifications required that they should stand five blows. Two wheels broke at 9 blows, while 50 required from 50 to 118 each. To start the first crack the average number of blows was 13.26; to break the wheel in two the average number of blows was 49.56. The

average depth of the chill at the root of the flange in the 105 wheels broken was $\frac{7}{16}$ in., and the depth did not vary in any case more than $\frac{1}{8}$ in. around the wheels. None of the wheels inspected were rejected because of chill-cracks, blow-holes or other imperfections, and none needed to be ground nor in any other way made smooth or true.

THE Pacific Rolling Mills, San Francisco, are adding to their works a bloomary for making steel blooms and a mill for rolling beams of large size. Heretofore there has been no mill of this kind on the Pacific Coast. The improvements will cost about $750,000 in all. The new machinery will include an engine of 1,000 H.P., which is to be built by the Risdon Iron & Locomotive Works in San Francisco.

THE works of the Simonds Rolling Machine Company at Fitchburg, Mass., are being enlarged. The company has 12 new machines of large size under construction, one of which is to be used for making steel projectiles for the Government.

Bridges.

THE Union Bridge Company has just finished a through bridge of 147 ft. 6-in span for the Clyde Viaduct in Chicago. The span has heavy, stiff lower chords with a heavy corrugated floor made of ob'ique Z-bars and plates. Mr. E. L. Corthell is the engineer.

THE Philadelphia & Reading Railroad has considerable heavy bridge work under way. First in importance is the Harrisburg Terminal for the new extension beyond Harrisburg. This comprises the Susquehanna River Bridge of 23 spans, 153 ft. 6 in. each, with 580 ft. of approach viaduct; the crossing over the Pennsylvania Railroad, one span of 160 ft. and a bridge across the canal of 60 ft. span. A new bridge is to be built at Port Clinton across the Schuylkill of three spans, one 200 ft., one 180 ft. and one 100 ft. There will be a bridge six miles above Port Clinton, crossing the Little Schuylkill River, of one 200-ft. span. Also a bridge of 98-ft. span at Williamsport. On opening the bids for the Susquehanna River Bridge it was found that Cofrode & Saylor, proprietors of the Philadelphia Bridge Works at Pottstown, Pa., had secured the main bridge, and the Phœnix Bridge Company the approach. The last-named company, however, threw up the contract, and it was also awarded to Cofrode & Saylor. The contracts for the other bridges mentioned were let to the Phœnix Bridge Company.

THE Pencoyd Bridge & Construction Company has the contract for the iron work for the elevation of the Pennsylvania Railroad tracks in Jersey City. Four tracks will be elevated.

THE Union Bridge Company has commenced moving the tools and machinery from the Buffalo shops to Athens, Pa. The company will vacate the old shop in Buffalo some time in June. Work on the new buildings at Athens is progressing rapidly.

THE Phœnix and the Pencoyd Iron Companies are each adding two 20 ton open hearth furnaces to their steel plants. The foundations of both are well advanced.

THE Passaic Rolling Mill Company, Paterson, N. J., has contracts for a number of small bridges for the New York, Susquehanna & Western Railroad.

THE Phœnix Bridge Company is pushing work on the St. Louis Elevated Railroad. The drawings are complete, and the work will shortly be put in the shops.

THE Hilton Bridge Company, Albany, N. Y., has contracts for two 107-ft. spans for the West Shore Railroad and one 65-ft. four-track span for the New York Central & Hudson River; also for a number of spans for the Delaware & Hudson Canal Company.

THE Trenton Iron & Steel Company has the contract for the four-track bridge for the Central Railroad of New Jersey at Point of Rocks, near Jersey City.

THE last pin in the Red Rock Cantilever Bridge was driven at 3 : 30 P.M. on Thursday, May 7, and the first train passed over at noon on May 10. The bridge was completed none too soon, for on May 9 the crossing at the Needles was washed out by a flood in the Colorado River, and traffic both ways was delayed 12 hours. Since May 10 trains have been crossing the bridge regularly.

THE Union Bridge Company has the iron work for the Memphis Bridge over the Mississippi in the shop, and work is progressing actively.

OBITUARY.

THOMAS G. NOCK, who died in Rome, N. Y., April 20, aged 61 years, was born in England, but came to this country when a child. He learned his trade in Connecticut, and in 1854 became Superintendent of the Ripley Iron & Steel Works at Windsor Locks, Conn.; in 1864 he went to Rome, N. Y., as Superintendent of the Rome Iron Works and retained that position until the New York Locomotive Works were established, when he was appointed President.

MAJOR OTHO E. MICHAELIS, Ordnance Department, U. S. A., died at Augusta, Me., April 29, aged 47 years. He graduated from the New York City College and in 1863 entered the Signal Corps of the Army, and subsequently passed the necessary examination and was appointed Lieutenant in the Ordnance Department, where he served steadily, rising gradually to the rank of Major. He was an active and efficient officer, and was thoroughly posted in his work. He was a member of several engineering societies.

JOHN VAN NORTWICK, who died in Batavia, Ill., April 15, settled in Kane County, Ill., in 1837 and took part in the first railroad building in that State, having been Chief Engineer of the Galena & Chicago Union Railroad, and later of several of the short lines which were afterward formed into the Chicago, Burlington & Quincy. He was President of the last-named Company for eight years and was also Chief of the Corps of Engineers employed to lay out canals by the State. Of late years he was largely interested in manufacturing.

T. HASKINS DU PUY, who died in Orange, N. J., May 15, aged 69 years, was born in Philadelphia and educated as a civil engineer. He began work on the Delaware & Hudson Canal and was subsequently on the Pennsylvania Railroad, where he located and built part of the mountain section of the road. He also built some of the first iron bridges in this country. Later he held important positions on the Mobile & Ohio, the Chicago & Atlantic and several other roads. For several years past he has been in retirement on account of ill health. Mr. Du Puy was considered an engineer of excellent judgment, and he was also successful as a railroad manager.

HENRY B. RIEHLE, who died in Philadelphia, April 25, was the head of the firm of Riehle Brothers, and had been for many years engaged in the manufacture of scales and testing machines. He took an active part in the business of the firm with which he was connected, devoting the greater part of his time to the improvement of the several articles manufactured by them, and superintended the manufacturing interest at the works. His loss will be greatly felt in the business community and in the several religious and benevolent associations with which he was connected. Mr. Henry B. Riehle was connected with the firm of Riehle Brothers since its organization, nearly a quarter of a century ago. He leaves a widow and one child.

DAVID BANDERALI died in Paris, March 30, aged 54 years. He was educated as an engineer at the École Polytechnique and the École des Mines, and entered the service of the Northern Railroad Company of France in 1859. He rose gradually through the various grades until he became Chief Engineer of Material and Motive Power, which position he held until his death. He visited this country several times and was well known to many American engineers, not only from these visits, but from the many courtesies which he extended to them in return when visiting France. Monsieur Banderali was a fluent writer and published many articles in the French technical papers. He also stood very high as an engineer and head of a department, and was considered one of the foremost men in his profession in France. He was a careful student of American railroad practice, and advocated the adoption of many of its features in his own country.

JAMES NASMYTH, the distinguished mechanical engineer, died at his home in Kent, England, May 7, aged 81 years. He was born in Edinburgh, Scotland, and after studying for a time at the University of that city he went to London and entered the works of Henry Maudeslay, where he remained several years. In 1834 he established himself in business in Manchester, where he gradually built up a large factory. In 1839 he matured his first important invention, the steam hammer; this is also claimed by some French engineers, but there is no doubt that Mr. Nasmyth worked out his own idea independently. The steam hammer was followed by a safety ladle for foundries, a suction fan for ventilating mines, a reversible rolling mill, and a number of devices of lesser importance. In 1857, when his

firm—then Nasmyth, Gaskell & Company, of the Bridgewater Works—had become a large concern, he retired from active business altogether, and retired to a home which he had bought in Kent. After his retirement he wrote several important scientific works, and devoted a large part of his time to the study of astronomy, in which he was deeply interested. His autobiography—edited by Samuel Smiles—was published in 1883, and is a book of great interest. He was one of the few inventors who are also successful in business, and his later years were passed in a comfortable retirement.

PERSONALS.

JOHN S. SILVER has resigned his position as Vice-President of the National Car Spring Company.

JOHN H. WINDER is appointed Superintendent of the Seaboard & Roanoke and the Roanoke & Tar River Railroads.

E. M. ROBERTS has been appointed Master Mechanic of the East Tennessee, Virginia & Georgia Railroad at Atlanta, Ga.

R. N. CAMPBELL, late on the Chicago, Milwaukee & St. Paul, has gone to Jamaica, to take charge of a railroad on that island.

G. M. BEACH, late of the Chicago & Atlantic, has been appointed General Manager of the Pittsburgh & Lake Erie Railroad.

JAMES A. NORTON has been appointed Railroad Commissioner of Ohio, succeeding W. S. CAPPELLER, whose term has expired.

EDWARD P. RIPLEY has resigned his position as General Manager of the Chicago, Burlington & Quincy Railroad, to become Second Vice-President of the Chicago, Milwaukee & St. Paul.

GEORGE L. FOWLER has opened a mechanical engineering office at 171 Broadway, New York. He will give special attention to estimates, designs, and tests of machine tools, engines, and power machinery.

MAJOR JOHN C. WINDER has been appointed General Manager of the Seaboard & Roanoke Railroad and its controlled lines. Mr. L. T. MYERS succeeds Major Winder as General Superintendent of the same lines.

GEORGE B. HARRIS has succeeded Henry B. Stone as Second Vice-President of the Chicago, Burlington & Quincy Railroad Company. Mr. Harris has been General Manager of the Chicago, Burlington & Northern Railroad.

J. T. HARAHAN has been appointed General Manager of the Louisville, New Orleans & Texas Railroad, with office in Memphis, Tenn. He has served on the Louisville & Nashville, the Lake Shore, and the Chesapeake & Ohio.

JOHN CHAMBERLAIN has been appointed Master Car-Builder of the Boston & Maine Railroad, in place of D. C. RICHARDSON, who has resigned. Mr. Chamberlain was formerly Assistant to Mr. Adams on the Boston & Albany, but for some time past has been in charge of the car works at Wichita, Kan.

JOHN W. CLOUD, Secretary of the Master Car Builders' Association, has accepted the position of General Western Manager of the Westinghouse Air Brake Company, with headquarters in Chicago, and will take up his residence in that city immediately after the annual meeting of the Master Car Builders' Association in June.

ROBERT E. PETTIT has resigned his position as General Superintendent of the Pennsylvania Railroad Division of the Pennsylvania Railroad. He has been on the road for about 20 years, serving in the engineering department until 1882; in that year he was made Superintendent of the New York Division, and was promoted to his late position in 1885.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting, May 7, the progress for the arrangements of the Annual Convention was announced.

A paper on the Stability of Masonry Arches, by Mr. A. S. C. Wurtele, was read by title and the subject was informally discussed by a number of the members present, Messrs. Fteley, Hardy, Owen, Shinn, Cohen, Bogart and Brush giving instances from their experience.

The tellers announced the following elections: *Members:* Holland W. Baker, St. Louis; Henry H. Carter, Boston; Henry A. Herrick, Spokane Falls, Wash.; Edward C. Jordan, Portland, Me.; Gustave Kaufman, Allegheny, Pa.; John P. Kelly, Troy, N. Y.; Albert B. Knight, Butte City, Mont.; Olin D. Leisenring, Cleveland, O.; Otto J. Marstrand, Brooklyn, N. Y.; Albert S. Riffle, Walla Walla, Wash.; Charles W. Staniford, New York.

Associate: Malverd A. Howe, Terre Haute, Ind.

Juniors: George G. Earl, Montgomery, Ala.; Charles E. Fowler, Muncie, Ind.; William J. Stewart, Rochester, N. Y.; Arthur C. Wheatley, Henry C. Yeatman, San Cristobal de las Casas, Mexico; Albert H. Zeller, St. Louis, Mo.

Boston Society of Civil Engineers.—At the regular meeting in Boston, April 16, reports were received from the Committees on National Public Works, on Weights and Measures, on the Library, and on Highway Bridges. The last-named Committee reported in favor of conservative action, but believed that reform could best be obtained by free dissemination of information and by a law for the periodical examination of the structures. As a preliminary step they advised a commission of experts to report upon the condition of existing bridges, and to prepare recommendations for the Legislature.

Professor Woodbridge gave an account of the system of heating and ventilation of the new engineering building of the Massachusetts Institute of Technology.

New England Railroad Club.—At the regular meeting in Boston, May 14, the subject was the Length of Rigid Wheelbase permissible on American Railroads. Mr. F. M. Twombly read a paper on this subject, giving some notes of experience with different types of locomotives on the road having many curves.

The subject was discussed by Messrs. Richards, Marden, Allen and others. Mr. Marden stated that he had run special cars with 10-ft. wheel-base carrying exceptionally heavy loads, and also that he had cars running with 13-ft. wheel-base, and sharp flanges were almost unknown. He was satisfied that with any curve on New England roads with an 11-ft. wheel-base and M. C. B. standard axle, there was sufficient play given to prevent any bad effects.

Engineers' Club of Philadelphia.—At the regular meeting, March 15, Mr. T. Carpenter Smith presented an account of the Method of Towing Coal Barges on Western Rivers.

Mr. Wilfred Lewis presented an account of a recent visit to the works of the Simonds Rolling Machine Company in Fitchburg, Mass.

AT the regular meeting, April 19, it was decided to lay the matter of the revision of rules for the election of members on the table. An amendment changing the dues of members was presented.

Mr. Wilfred Lewis presented a description of a new Shaft Coupling for the transmission of power to traveling cranes, etc.

Mr. Easton Devonshire read a paper on the Purification of Water by Means of Metallic Iron, calling attention to applications of this process made in England and Belgium with much success.

AT the regular meeting, May 3, it was decided to resubmit the amendment increasing the dues of the resident members.

The Secretary presented for Mr. William H. Dechant a paper on the Mountain Railroads of Reading, Pa., accompanied by a map giving the alignments of the roads, which are generally gravity lines.

The Secretary presented for Mr. J. Foster Crowell a paper on Interoceanic Canal Prospects, describing the present condition of the Panama Canal works, and also the condition of affairs in Nicaragua.

Mr. Edwin S. Crawley presented a paper on the Lobnitz System for Breaking up Rocks under Water without Explosives. The principle consists in producing a shattering of the rock by the action of a heavy mass dropped from a convenient height and acting like a projectile.

Engineers' Society of Western Pennsylvania.—At the regular meeting in Pittsburgh, February 18, Mr. A. Dempster presented the report of the delegation appointed to attend the convention held in Harrisburg, January 23, to discuss changes in the road laws of the State. It was voted to continue the Committee on Highway Roads, with instructions to report from time to time.

Mr. Dempster then read an interesting and practical paper on

the Road Problem, which was discussed by Messrs. Wilkins, Roberts, Kirk, Johnson, Becker and others.

Mr. Simon H. Stupakoff was elected a member of the Society.

AT the regular meeting in Pittsburgh, March 20, L. B. Stillwell read a paper on Distribution of Light and Power by Electricity. He stated, among other things, that the capital now invested in electric light and power companies amounted to over $275,000,000, and that there are 109 street railroads with 580 miles of track now operated by electricity.

AT the regular monthly meeting in Pittsburgh, April 15, Mr. W. C. Quincy read a paper on Reminiscences of Railroad Building on the Baltimore & Ohio. He gave extracts from the early reports of the road, and mentioned his experience in 1849, when he was a member of an engineering party having in charge the building of tunnels on the western part of the road. There was some discussion by members present.

The following were elected members of the Society: Daniel Ashworth, W. A. Giles, William Morgan, James Ritchie, Fred. A. Scheffler, and Charles F. Scott.

Civil Engineers' Club of Cleveland.—At the regular meeting, May 13, Mr. C. O. Palmer resigned his position as Secretary of the Club. A Memoir on the Life of Mr. James S. Oviatt, a late member, was read.

The Committee on Affiliation with the American Society of Civil Engineers presented a report which was accepted, and the Committee requested to attend the Conference in New York in June. Mr. Thompson presented the Club with a carved stone containing the name of the late Charles Latimer.

Mr. G. A. Hyde read a paper on Gas-holder Tanks, in which the difficulties of founding large tanks on a hill-side composed of alternate layers of clay and quicksand were shown. This was followed by a general discussion, which turned principally on the nature of the soils about Cleveland.

Engineers' Club of Cincinnati.—At the regular April meeting of the Club one new member was elected and four applications for membership were received.

Professor T. H. Norton, of the University of Cincinnati, delivered a very interesting lecture on Aluminium, the metal which is at present receiving so much attention from metallurgists and engineers, and which is destined to be the metal of the future, on account of its adaptability for use for a multitude of purposes where iron and steel are now employed, the only drawback to its general use at present being the great expense attendant upon obtaining it in a commercial form. This, however, by reason of various experiments and the improvements made in the manner of manipulation, is being rapidly overcome.

AT the regular March meeting of the Club three new members were elected and one application for membership received. The date for holding the regular meeting in April was changed from the third to the fourth Thursday.

The paper prepared and read by Colonel William E. Merrill comprised an extended review of the history, extent, development, conduct, and cost of the construction and maintenance of the inland navigable water-ways of France, which include 3,000 miles of canals, 2,050 miles of canalized rivers, and 1,850 miles of rivers that are used for purposes of navigation, which are all with slight exceptions under the management of the Government.

Engineering Association of the Southwest.—At the regular meeting in Nashville, Tenn., May 8, Messrs. Kenneth McDonald, Donald McDonald and Dexter Belknap, all of Louisville, Ky., were elected members.

The Executive Committee presented a report recommending a limited form of affiliation with the American Society of Civil Engineers, the Association to retain its independence in all matters of management, election of members, etc. The report also suggested a general affiliation of all engineering societies. After discussion it was adopted, and Messrs. McLeod, Landreth and Foster were appointed a committee to attend the meeting of the American Society in June, as representatives.

Mr. George Reyer read a paper on the Duty Test of the Holly-Gaskill Engine at the Nashville Water Works. The engine is a vertical compound condensing engine, with two high-pressure cylinders 33 in. and two low-pressure cylinders 66 in. in diameter, all 60 in. stroke. The pumps are single-acting plunger pumps 27 in. in diameter placed in a dry well directly under the steam cylinders, the pump-rods being extensions of the piston-rods. The latter are also connected by overhead beams and connecting rods to cranks, set at an angle of 90°, on a shaft carrying a 24-ft. fly-wheel. The condenser is a surface condenser, and there are four air-pumps and four feed-pumps driven from the main engines. The test gave these results: Duration of test, 4 days, 8 hours and 52 minutes. Total U. S. gallons pumped, 49,776,080; average head pumped against, 268.7 ft.; actual duty of boiler and engine per hundred pounds of coal consumed, 72,223,992 ft.-lbs.; duty of engine alone per 500 lbs. of steam used, crediting engine with work done by feed-pump and with heat imparted to feed-water by condenser, 94,263,339 ft.-lbs.; revolutions during test 85,249; gallons pumped (computed by displacement), 50,711,220; relative per cent. of slip, 1.84; average capacity per 24 hours, 11,365,628 gallons; actual evaporation per pound of coal from feed at 50° F. to steam at 80 lbs. pressure, 6.35 lbs.; equivalent evaporation per pound combustible from and at 212° F., 9.31 lbs.

The paper was discussed by members present, and it was stated that the leakage of the reservoir and of the force-main (four miles in length) averaged 507,400 gallons per 24 hours, when the reservoir was filled to a depth of 31 ft. The reservoir is composed of solid rubble masonry walls, from 36 ft. to 38 ft. high, 8 ft. thick at top and 26 ft. at bottom, curved in profile, with concrete core throughout the full height.

Professor Landreth showed and explained a new binocular hand-level, making the objection that it was liable to error, as the accuracy of its work was dependent on a perfectly balanced condition of the vertical muscles moving the two eye-balls of the observer—a condition very rarely existing. Experiment had supported this objection.

Engineers' Club of St. Louis.—At the regular meeting in St. Louis, March 19, Professor J. B. Johnson read an address on the Organization of a Federal Council of Engineers, the paper being the result of his investigations as member of the Committee selected to prepare an address to the engineers of the country on this subject. He mentioned as among the functions of a general organization the establishment of uniform qualifications for admission to the different societies; proper definition of the title engineer; the formation of a joint library; joint publication of papers and representation in the control of State and municipal engineering works.

This called out a long and active discussion, in which Messrs. Sedden, Meier, Moore, McMath, Potter, Ferguson, Wheeler, Beahan and Taussig took part, considerable opposition being manifested to the proposed general organization.

AT the regular meeting, April 2, Frederick Egner, John J. Sanders and James N. Tiernan were elected members.

Mr. Thomas Long addressed the Club on the erection of some recent large bridges, showing a number of views of the new Merchants' Bridge at St. Louis, the Cairo Bridge and others.

Mr. Frank Nicholoson read a paper on the Pemberton Concentrator, in which he said that there was a widespread opinion that the concentration of ores was of doubtful value. This was followed by a discussion in which strong opinions were expressed as to their usefulness.

AT the regular meeting, April 16, the Committee on Affiliation with the American Society of Civil Engineers submitted a report which was made a special order for discussion at the next meeting.

Mr. Isaac A. Smith read a paper on Railroad Inclines, giving experience in their construction and operation, and suggesting some improvements. This paper was discussed by members present.

The Secretary read a paper by Mr. Arthur J. Frith on the Screw as an Element of Mechanism, giving considerations as to the proper design of the screw for different purposes and to its uses as a means of transmitting power. This paper was also discussed by members present.

Mr. Robert Moore exhibited some cubes of clay taken from the bottom of the Mississippi at Memphis. Professor Johnson gave the Club some data regarding recent Tests of Granitoid Beams, which showed that a mixture of six parts of granite to one of Portland cement was stronger than mixtures having larger portions of cement. This statement was very fully discussed.

AT the regular meeting, May 7, Professor Arthur T. Woods read a paper on Compound Locomotives, with illustrations. Mr. Otto Schmitz read a paper on Granitoid Curb and Gutter, giving particulars of the composition of the artificial stone known by that name. Both papers were discussed by members present.

The special order was then taken up, being the report of the

Committee on Affiliation with the American Society of Civil Engineers. This report was very full, and proposed as the outline of a plan to confer upon any association of engineers, one-fifth of whose members are connected with the American Society, the privilege of becoming a branch or chapter of that Society, in a restricted sense, the constitution to be in harmony with that of the general society. Such associations are to be independent of each other, and to be represented in the American Society only by such of their number as are members of that Society; they were to be also self-governing as to all local circumstances. Professional papers submitted to the branches are to be published by the American Society, the local club to make contribution to the cost of publication at rates to be fixed. Provision should be made for two general meetings of the Central Society in each year at which all business affecting general interests should be transacted.

This report was discussed at some length, and it was voted that the recommendations on the Committee be adopted as the sentiment of the Club, and that notice should be sent to all other engineering societies.

Western Society of Engineers.—At the regular meeting in Chicago, May 7, the Committee on Rapid Transit and Terminal Facilities in Chicago presented a report offering three plans for discussion: 1. A complete system of elevated roads. 2. A complete system of depressed tracks. 3. A system partly elevated and partly on the surface. A minority report was also presented recommending the third system only. Letters on the subject were read from a number of engineers and railroadmen, and estimates and plans were also presented by Mr. A. F. Robinson and Colonel Richard P. Morgan. The discussion will be continued.

Northwest Railroad Club.—At the regular meeting in St. Paul, May 10, the first subject for discussion was Driver Brakes, which was introduced by Mr. William McIntosh.

The second subject was the Master Car Builders' Rules for Interchange, with the amendments expedient. This was introduced by Mr. G. F. Ward, and was generally discussed by members present.

Engineers' Club of Minneapolis.—A new club under this name was organized in Minneapolis, Minn., May 7, taking the place of the old organization. Meetings will be held once a month, and it is hoped that the Club will be active and successful. The officers are: President, Professor W. A. Pike; Vice-President, William De La Barre; Secretary and Treasurer, F. W. Cappelen; Librarian, W. W. Redfield.

Northwestern Track & Bridge Association.—At the regular meeting in St. Paul, Minn., March 15, Mr. James Manning read a paper on the Best Method of Protecting Track from Snow. In this paper he spoke at considerable length on snow fences and their proper arrangement, recommending that they should be at least 8 ft. high, and, as a rule, should be placed 100 ft. from the track. He also spoke of the planting of trees at cuts, recommending willows for this purpose, and said that in prairie country a great deal can be done by raising the grade line slightly above the general surface. This paper was generally discussed by the members present, and Mr. Manning's recommendations as to fences were approved by vote.

The Elevation of Track on Curves and Cattle Guards and Culverts were selected as subjects for the next meeting.

At the regular meeting in St. Paul, Minn., April 12, Mr. G. W. Downing read a paper on the Elevation of Track on Curves, which was generally discussed; as usual many differences of opinion were developed on this point.

The second subject for the evening was Cattle Guards and Culverts, which was discussed by Messrs. Stevens, Copeland, Downing, Pearson, and others.

Denver Society of Civil Engineers.—At the regular meeting in Denver, Col., April 22, it was decided to hold a convention of all the civil engineers in the State at Manitou, about the time of the opening of the rack-railroad up Pike's Peak.

Mr. C. G. Anderson read a long and interesting paper on Large Irrigation Canals, treating of their construction, maintenance, and operation very fully.

Engineers' Club of Kansas City.—On Friday evening, February 28, the Club held its Annual Dinner at the St. James Hotel, Kansas City. There were 33 present, including 22 members and invited guests. After a most satisfactory repast toasts were responded to by President W. H. Breithaupt, O. B. Gunn, F. E. Sickels, K. Allen, A. J. Mason, G. W. Pearsons and D. W. Pike, and entertaining reminiscences of engineering experience were given by Mayor Davenport, Major Gunn, Mr. E. I. Farnsworth and Mr. Henry Goldmark. Mr. William B. Knight filled the office of toast master in a most satisfactory manner.

At the regular meeting, March 3, R. J. McCarty was chosen a member. It was resolved to hold meetings hereafter on the second Monday of each month. The Secretary presented in behalf of Mr. Thomes a large number of valuable Government Reports.

Mr. G. W. Pearsons read a paper on Photography applied to Surveying, in which he said: "The focal length of camera best adapted to this work is from 12 to 15 in. The image formed on the sensitive plate represents a series of right lines passing through the center of the lens from the landscape to it. If, therefore, the plate is in correct position it will give a mathematically correct copy, capable of direct measurement, and to a much greater degree of accuracy than would be at first imagined.

"For purposes of precision proper regard must be paid to the positions of the plate and camera. The former must be truly vertical, and, for a proper definition of the horizon, its edges should be horizontal. The angle covered by the plate must be known, and sufficient lap should be allowed to join consecutive prints.

"The centers of plates should be correctly located, vertically and horizontally, as they must be measured by a scale of tangents from the vertical center and horizon. The focal distance should remain fixed.

"After taking a series of views from the first station, proceed to the next point and take another set in the same manner, intersecting the first. The points of observation being known, these intersections determine any desired point in the field of view. The third station bears on the first two, the fourth on the second and third, etc., forming a continuous triangulation on which most points may be defined by three intersections. Any point so determined is also defined as to height by the tangent of its distance from the point of observation. The plates, therefore, give vertical as well as horizontal definitions of the field, and with a degree of accuracy which will surprise the engineer."

At the regular meeting, May 1, Karl Wenntrock was chosen a member, and E. J. Lawless an associate.

Colonel S. N. Stewart made an address on Draw Bridges Closed by Water Power, and on Water Motors as used in Europe. Three methods of closing floating draws by the current of a river were shown: in the first the current acting directly on large wings or planks; in the second the draw is closed by a car, which is forced up an inclined road by the action of the current, and in the third it is closed by the action of the current on a boat with submerged vanes. It was also stated that motors operated by the current of a stream were used very much more in Europe than in this country.

Montana Society of Civil Engineers.—At the regular meeting in Helena, Mont., March 15, an amendment in relation to the election of candidates was proposed and submitted to ballot.

The Secretary was instructed to send printed copies of the Society's letter to Honorable T. H. Carter on the subject of Public Land Surveys to the surveyors general of the different States and Territories and to the secretaries of the different engineering societies, asking for their co-operation in securing the reforms in the present system of surveys recommended in the letter. Also to send copies to the Congressmen from the Western States.

Mr. Keerl exhibited a fine transit made by Buff & Berger, of Boston, used in the construction of the Wickes Tunnel on the Montana Central. Discussion followed on different styles of engineering instruments.

Technical Society of the Pacific Coast.—At the regular April meeting in San Francisco, a committee, consisting of Messrs. L. Wagoner, E. J. Molera, Ross E. Browne, F. Soulé, and L. M. Clement, was appointed to make investigations to determine the yielding of the Bear Valley Dam under strain, in pursuance of the suggestions made by the American Society of Civil Engineers.

Mr. Randall Hunt read a paper on Coffer Dams and Founda-

tions under Water, describing the caissons used in building the sea-wall at the foot of Market Street, San Francisco.

Mr. L. Wagoner described a singular structural change of material under strain—a lateral shrinkage of metal rods from elongation beyond the elastic limit, not uniform but intolerably well defined strata or sections transverse to the axis. He also explained how the spectrum gave colors varied by stress in cylinders of glass. Further experiments are to be made on this point by Mr. Wagoner and Commander Gilmore, U. S. N., and the results will be submitted to the Society.

Master Mechanics' Association.—The Committee on Brick Arches in Locomotive Fire-boxes has asked for information on that subject, requesting members to send their experience with such devices and also descriptions and drawings of the plans used.

Master Car-Builders' Association.—The 24th annual convention will be held at Old Point Comfort, Va., commencing Tuesday, June 10, at 10 A.M.

Headquarters will be at the Hygeia Hotel.

The revision of the Rules of Interchange is the special order of business at 10 A.M., on Wednesday, June 11.

National Convention of Railroad Commissioners.—The Committee appointed at the meeting held in March, 1889, has issued a call for a second convention, to be composed of the Interstate Commerce Commission and the Railroad Commissioners of the several States. This convention was to meet in Washington, May 28; the subjects suggested for consideration are: Harmony in Railroad Legislation; Annual Reports from Carriers; Uniformity in Railroad Accounting; Classification of Railroad Statistics; Classification of Freight; Regulating Railroad Construction; State Railroads; Reasonable Rates, and Safety Appliances for Railroad Cars.

American Society of Mechanical Engineers.—Cincinnati was selected as the place for holding the annual convention of the Society of Mechanical Engineers this year. The first session was held in the Scottish Rite Cathedral, on Tuesday evening, May 13, at 8 P.M. The meeting was opened by Mr. George A. Gray, of Cincinnati, who introduced Mr. M. E. Ingalls, President of the Cleveland, Columbus, Cincinnati & St. Louis Railroad, who made a happy reception address, and Professor H. T. Eddy, Dean of the University of Cincinnati, also welcomed the Society with a few brief remarks. To this cordial reception Mr. Oberlin Smith, the President of the Association, responded. Owing to the illness of a member of his family Secretary F. R. Hutton could not attend the meeting. Mr. C. J. H. Woodbury therefore acted in his place.

After the welcome and the response the Society proceeded immediately to the business for which it was assembled. Abstracts of the following papers were read:

J. E. Denton: The Measure of Durability of Lubricants.

C. S. Dutton: Some Experiences with Crane Chains.

George H. Barrus: Memoranda on Indicating Engines of the Steamer *City of Richmond*.

Each paper was discussed, many of the engineers taking part. After the regular exercises a lunch was served, and the members of the Society were given the opportunity of becoming acquainted.

Wednesday was the field day of the convention, and sessions were held in the morning, afternoon, and evening. At the opening of the morning session the Secretary's report was read, and reports were read on the Duty of Pumping Engines—which was accepted; on Standard Tests and Methods of Testing Materials—which was not final, so the Committee was continued; on Standard Dimensions of Pipe Flanges—read and Committee continued.

Mr. Forsyth moved that a Committee of seven be appointed to report on methods of testing locomotives. The resolution was advocated by Messrs. Wall, Webber, Strong, and Barrus, and was then adopted. Subsequently the following Committee was appointed: Professor C. B. Richards, H. B. Stone, Allen Stirling, F. W. Dean, William Forsyth, James E. Denton, and Axel Vogt.

The first paper read at the morning session was one by Mr. W. F. Dixon on the Efficiency of Locomotives. It was discussed at considerable length, but nothing very new was brought out. The compound locomotive was talked about in a desultory way, but none of those who took part in the discussion had any important facts to present. So far the advantages of the compound locomotive seem to be like a Scotch verdict, "not proven." The friends of the system report an economy of from 15 to 20 per cent. in fuel consumption. Whether this will be sufficient to compensate for the increased first cost and cost of repairs still remains to be shown.

The next paper was on Working Railroads by Electricity, by Willis E. Hall, and called out an animated discussion. In a written commentary on this paper Mr. Scheffler attempted to refute some of Mr. Hall's data, and tried to prove that the expense of operating an electric railroad, if much power was required, would be so great as to be prohibitory.

Mr. Spaulding said that if the data quoted by Mr. Scheffler were correct, most of the electric railroads were now on the verge of ruin. He also called attention to the fact that electric motors had considerably more adhesion than ordinary locomotives. The reason, he thought, was not yet fully understood, but the fact had often been observed. The absence of reciprocating parts in electric motors was also an important matter, and he thought that ultimately water power would be utilized for running electric motors.

Another member said that the application of a higher degree of mechanical skill to the problem of electrical science would be very advantageous, and that the amount of quackery which has been palmed off on the public as electrical engineering would seem incredible to those who have not had opportunities to know of it.

Mr. Barker observed that there was now a disposition to return to the use of a separate motor rather than to drive from each axle.

Mr. Sweeney called attention to the fact that electric locomotives could be run and managed by a cheaper class of labor than is required to manage steam locomotives. The expense of applying an electric motor to each car is a serious difficulty in propelling them in that way.

Mr. Rogers thought that the motive power on electric railroads should be distributed over the whole train. He would also like to learn the reason for the increased adhesion of electric motors.

Mr. Webber said that it did not follow that a large trunk line railroad could be operated successfully and profitably with electricity because a street road could be worked by such means.

The discussion was of a very desultory character, and was chiefly an expression of the anticipations of those who took part in it, and to a great extent was a sort of engineering "Looking Backward."

The next paper was on the Determination of Sensitiveness of Automatic Sprinklers, by A. F. Nagle. Mr. Woodbury quoted statistics of the cost of fires with and without sprinklers, showing that when sprinklers were used the loss from fires was only about 6⅔ per cent. of what it was when they were not used. He also referred to the defects of many sprinklers which are used, and said that he has many specimens which would be no more use in preventing fires than so many Hindoo idols would be.

Papers were then read on Hirn & Dwelshauvers' Theory of the Real Steam Engine, by Professor Thurston; Tests of Several Types of Engines under Conditions found in Actual Practice, by R. C. Carpenter; Comparative Tests of a Hot Water and a Steam Heating Plant; Note on Kerosene in a Steam Boiler, both by Mr. Carpenter.

At the afternoon and evening sessions the following papers were read and discussed: A Use for Inertia in Shaft Governors, by E. J. Armstrong; A Governor for Steam Engines, by Jesse M. Smith; Effect of an Unbalanced Eccentric in Shaft-Governed Engines, by John E. Sweet; An Open-end Mercury Column for High Pressures; An Automatic Absorption Dynamometer, by G. J. Alden; Peclet's Treatment of Chimney Draft, by J. B. Webb; the Mechanical Theory of Chimney Draft, by J. B. Webb; Graphic Representation of Thermodynamic Quantities, by Professor De Volson Wood; Test of a Refrigerating Plant by the same author; A Universal Calorimeter, by George H. Barrus.

Thursday was devoted to excursions. At the invitation of the Niles Tool Works, the members of the Society took a special train in the morning and visited that establishment at Hamilton. After spending several hours in looking through these well-equipped works, they were taken to picnic grounds a few miles from Hamilton, and a bountiful lunch was served. Music, wine, and dancing gave a delightful coloring to engineering subjects. On the return of the train to Cincinnati it stopped at Ivorydale, and the members visited the soap works where the famous ivory soap is made. Each member—and his wife, if he had one with him—was presented with a cake of soap, with the assurance that if properly applied it would keep even a person's conscience clean.

In the evening a reception was given to the members by citizens of Cincinnati at the Art Museum. A local reporter described the reception as follows:

"The Art Museum, shining afar from its lofty seat, was the scene of a very brilliant social event. From 8.30 until 10 the

roll of carriages to its doors was ceaseless, while every street car was packed. At 10 o'clock, when the reception was at its height, fully 700 people were walking about through its broad corridors, admiring the treasures of art which adorn them. The Cincinnati orchestra played in the balcony overlooking the entrance hall. The gentlemen were almost all in full evening dress; the ladies in demi-toilettes, and some in full evening dress. It was an assembly of Cincinnati's best society together with the visitors.

"Something after 9 o'clock Sir A. T. Goshorn welcomed the guests of the evening, and Mr. Woodbury replied."

The last session was held on Friday, when the remaining papers were read and discussed. These were on Heating Furnaces, by D. K. Nicholson; Equilibrium Arch Curves, by H. H. Suplee; the Kinzua Viaduct, 1882, by T. C. Clarke; the Length of an Indicator Card, by J. B. Webb; Indicator Cards of the Pawtucket Pumping Engine, by D. S. Jacobus, and on the Effective Area of Propeller Screws.

NOTES AND NEWS.

A Well-Equipped School.—The workshops of the Rose Polytechnic School at Terre Haute, Ind., are, it is claimed, the most complete of any of their class in the country. In the course in Mechanical Engineering particular attention is paid to shop practice and actual construction, the students being required to work in the shops as well as in the drawing rooms and lecture rooms. Over $40,000 were expended in fitting up these shops and supplying them with tools.

Multiple Screw Propulsion.—Although the exigencies of safe marine propulsion clearly enough demonstrate the necessity for spreading the enormous power required in our largest and swiftest steamships over two or more sets of engines, shafting, and propellers, the superior propulsive efficiency of twin-screws still remains a matter for serious doubt. Exhaustive experiments were made in France about four years ago, at the instance of M. de Bussy, to ascertain whether multiple screws would so interfere with each other as to give bad results in steaming. These experiments went to show that, for vessels of suitable form, the use of three screws, having a ratio of pitch to diameter differing but little from that ordinarily in use for vessels having single or twin screws—one in the center, placed just before the rudder, and one at each side, some distance in front of the center one—gives results from the point of view of speed very nearly equivalent to two screws of the same propulsive surface and immersed to the same depth. Whether or not this may be taken as conclusively representative of the comparative efficiency of two and of three or more screws, there can be no doubt it goes far to justify the employment of twin-screws in large full-power vessels, even from the point of view of propulsive efficiency. Efficiency apart, however, the chief obstacles which have hitherto been in the way of the adoption of twin-screws in vessels of moderate power have partaken more of a commercial than a scientific character. These obstacles comprise the necessity for duplicate sets of engines with all their various parts and complicated details, the great additional first cost, the more expensive up-keep, the extra engine-room staff entailed, and the extra space taken up in the vessel. Of these several objections, the principal ones—those which relate to extra weight and cost, extra space taken up, and extra engine-room staff—are attempted to be met by an invention recently patented by Mr. Hugh Dunsmuir, of the firm of Messrs. Dunsmuir & Jackson, Govan Engine Works, Glasgow, who are about to fit it in two light-draft vessels for Indian river service. This is an arrangement for working multiple screw propellers by means of one set of direct-acting engines placed athwartship in the vessel to be propelled.—*The London Engineer.*

Big Guns.—At a dinner of the members of The Institution of Naval Architects, Lord George Hamilton, the First Lord of the Admiralty, argued in favor of the heavy ordnance, about which there has been considerable unfavorable comment of late. In defending these guns he said: "The one object of all naval and of all military tacticians is to concentrate force on a given space and within a given area; and they do so because they believe that not merely the material destruction which the concentration of fire effects, but the moral effect of the damage which it does is of enormous importance. . . .

"The moment we come to ordnance of such a caliber as a projectile which cannot be lifted by one or two men, so far as rapidity of fire is concerned it is almost immaterial what is the size of the gun. There is little difference between the rapidity with which the 35-ton gun and the 110-ton gun can be loaded, for the mechanical engineer supplies appliances by which every gun can be loaded and reloaded with almost equal rapidity. In certain quarters there is a great wish that we should substitute manual effort for mechanical power in loading guns of a certain caliber."

Lord George Hamilton considered that all the objections against loading and training guns by mechanical power are a mere reproduction of the objections which were urged against the substitution of steam for sail power. Mechanical power may occasionally break down, but the speaker believed there was no machinery on board a man-of-war so unlikely to break down as the hydraulic power by which the great guns are loaded and trained. But if mechanical power be substituted for manual power in loading, the men must stand level with their guns, and protection must be afforded them, otherwise they can be swept away by the smallest gun. This means adding extra weight and offering a much larger target to the projectile of the enemy.

Color-Blindness at Sea.—In a paper on the Washington Maritime Conference Rear-Admiral P. H. Colomb, R.N., said: "The Conference dealt wholly with the question of color-blindness, on account of its danger with reference to the red and green side lights. I never knew, myself, a case of collision where color-blindness was in question. The statements are generally perfectly clear that wrong helm was given deliberately in the face of the color seen; and as no authoritative teaching has existed to show that it mattered what color was seen as long as danger was denoted, I have never been able to lay stress on the color-blind question."

Light Railroads.—Among the light railroads in use must now be counted a system devised by a Swedish engineer, Herr Axel F. Hummel, which is being adopted in Scandinavia, there being over 300 miles in use. For instance, on the Kosta-Lessebo Railroad, joining the Carlscrona-Vexio, Railroad the width of the gauge is 24 in., the steel rails having a weight of 18.2 lbs. per yard. The width of the formation is 9 ft. 3 in., and the radius of the curves mostly under 300 ft., and some not more than 70 ft. The gradients are as much as 1 in 35, and this has enabled the constructors to dispense with costly works. In spite of the steep gradients and sharp curves, 12-ton compound locomotives are used, having four cylinders and eight directly-driven wheels, and these are capable of hauling a train loaded with 40 tons at a speed of 15 miles an hour. The engines are provided with tenders, and a pressure of 165 lbs. is used. The trucks load from four tons to five tons, their own weight being one ton to 1.3 ton. The average cost of these railroads is given at $6,700 per mile. In Norway a railroad is to be constructed upon this system, 48 miles in length, from Christiania to Roken, but the value of the land will in that case make the estimated cost $16,100 per mile.—*The Engineer.*

Forced Draft in the British Navy.—Of a recent discussion of this subject at the meeting of the Institution of Naval Architects, *The Engineer* says: "The use of forced draft is now to all intents and purposes prohibited in the Navy," and "at sea it is in her Majesty's Navy a total failure." The nature of the failure is that the tubes all leak at the combustion chamber end if the fires are urged by fans beyond a certain point. One of the speakers, Admiral de Horsey, in the discussion of the subject, said: "The use of forced draft was now totally prohibited in ships-of-war, except under conditions of great emergency, and then it was only to be used for a very short time."

Railroad Accidents in Michigan.—The report of the Michigan Railroad Commissioner for 1889 says that on the railroads of the State during that year 160 persons were killed—of whom 7 only were passengers, 63 railroad employés, and 90 other persons—and 365 were injured, the list including 21 passengers, 256 employés, and 88 other persons. There were thus casualties to 28 passengers, 319 employés, and 178 other persons; a total of 525. The causes are shown in the following table:

	Killed			Injured		
	Passengers.	Employés.	Others.	Passengers.	Employés.	Others.
Collisions	....	....	....	....	2	....
Derailments	....	4	....	5	16	....
Coupling cars	....	10	....	....	144	....
Falling from trains	3	15	....	4	25	....
Getting on and off trains	2	5	3	6	11	3
Overhead obstructions	....	....	....	....	1	....
Miscellaneous	2	28	5	6	56	3
Trespassers on trains	....	....	11	....	1	30
At highway crossings	....	....	19	....	....	22
Trespassers on track	....	1	52	....	....	30
Total	7	63	90	21	256	88

On these figures the Commissioner makes the following comments:

"We have to report but two injuries from collisions, a decrease of 20 from the previous year, and the hope that we expressed for such a result in our last report has been satisfactorily fulfilled. From derailments 25 persons were injured, as against 20 in 1887.

"The casualties from coupling cars continue to increase, notwithstanding the exertions being made by nearly every company in the land for their prevention. For the year under report we have an increase of 13.

"Notwithstanding every effort by this office for the prevention of accidents at highway crossings, the number continues to increase, and we have a record of 19 persons killed and 22 injured, as against 15 killed and 22 injured in the preceding year.

"Falling from trains continues to be a prolific cause of fatality on our roads, 18 having been thus killed and 29 injured during the past year, of which number 7 were passengers and 40 employés. The sad commentary upon this record is that in nearly every case the death or injury resulted from the neglect or want of caution on the part of the sufferers themselves.

"Two passengers, 5 employés, and 3 others were killed, 6 passengers, 11 employés, and 3 others injured in attempting to board or leave trains while in motion—a total of 30 persons killed or crippled for lack of thoughtful care and discretion.

"For the want of wholesome legislation which would authorize, under proper restrictions, the arrest of persons found trespassing on railroad properties, there is no abatement in the work of their taking off. There were 123 of that unfortunate class run over last year and either killed or maimed for life; an increase of 15 over the previous year."

A Water Telephone.—An instrument of this kind was recently patented in England by W. Walker, of London.

In apparatus employed for the collection of sound transmitted through water, such as between ships, some difficulty is experienced in properly recording the sounds on account of the instrument being worked by other causes, such as the movement of the ship. The inventor remedies this defect by constructing the apparatus so that any pressure caused by the increased density of the water has no effect upon such apparatus. Referring to the illustration, the telephonic receiver *C* is secured concentrically within the cup *D*. By a passage *E* the cup *D* communicates with a closed tube *F*. Passing through the tube *F* is a second tube *H* having at its upper end an orifice *I*. One end of the tube *H* leads to the chamber *C*, and the other to a pressure gauge on the ship. *A* is the diaphragm of the receiver. The action of the apparatus is as follows: Assuming the same to be applied to a ship, any alteration that takes place in the position or motion thereof will cause a difference in the external pressure acting upon the diaphragm *A*, which is counterbalanced internally by the pressure of air in the chamber *C* and tube *H* caused by the water rising in the chamber *F* in proportion to the depth to which the instrument is immersed. This compen-

FIG. 1

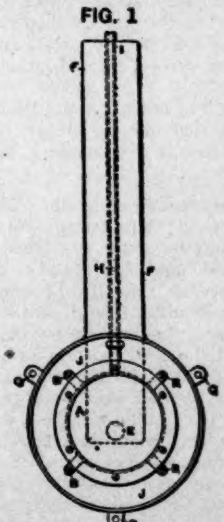
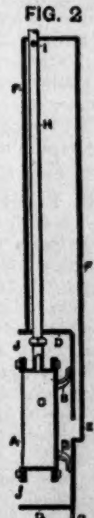


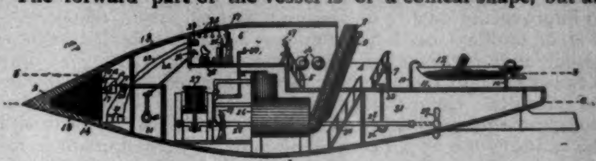
FIG. 2



sation takes place each time the apparatus is raised or lowered by the motion of the ship in the water, and ensures only the sound waves affecting the diaphragm. The area of the space *J* through which the water enters to the chamber *F* being equal to the area of the diaphragm *A*, an equal pressure acts upon each when the instrument is so placed as to receive the full force of the water through which it is passing, or which is passing it; by this arrangement the equilibrium of the diaphragm is maintained.—*Industries.*

A Self-Destructive War-ship.—The accompanying illustration shows a torpedo boat invented by Samuel Barton, of New York, and recently patented by him, the number of the patent being 423,405. It is substantially a huge torpedo, provided with engine and boiler and carrying a crew, and is also provided with a steam launch by which the crew may make their escape after bringing the ship into action.

The forward part of the vessel is of a conical shape, but at



the back end is a flat deck, upon which the steam launch is carried. The roof or deck is of sufficient thickness, in combination with its circular shape, to prevent damage from shells. The charge of dynamite or other explosive is carried in the bow at 13 14, and the charge may be exploded by electricity, means for that purpose being provided, or by the impact or shock of striking. The greater part of the rest of the space is taken up by the engine and boiler, for as it is not expected to make long trips it is not considered necessary to carry any large supply of fuel or stores. In action the vessel would be first taken to a convenient point, then submerged from the ordinary water-line *a a* to the line *b b*, then steamed at full speed toward the vessel to be attacked. The crew would then take their places in the steam launch, leaving only the pilot and the officer charged with completing the circuit for the explosion in the vessel. The electrical connection may be so arranged that the act of striking the vessel attacked would explode the charge. The pilot and his associate having remained on board until the last possible moment would jump overboard, and, being provided with life-preservers, could be picked up by the launch. The inventor claims that a very heavy charge of explosive could be carried in this way, and that the explosion, while it would of course destroy the vessel itself, would also destroy the largest iron-clad afloat. The risk, of course, is great, but he believes that it would be possible for all the crew to escape. This may perhaps be considered as a revival, with modern improvements, of the fire-ship employed in former times; at least it is an enlargement of the torpedo idea.

Nickel in Canada.—On a little branch of the Canadian Pacific Railroad near Sudbury, P. Q., is a nickel mine that produces more nickel, it is said, than the entire market of the world calls for. It is found at a depth of about 300 ft. below the surface, in a layer of oxidized Laurentian rock characteristic of that region. Immediately the mineral is hoisted from the mine it is broken up and calcined, or roasted, for the purpose of eliminating the sulphur it contains. When this process is completed, the residuum is conveyed to the smelter. After the dross of the molten metal flows off, the nearly pure nickel and copper are blended together, forming an alloy, 70 per cent. of which is nickel and 30 per cent. copper, which is drawn off at the base of the furnace and allowed to cool. When cold, the product is shipped to Swansea, Wales, and Germany, where the constituent metals are separated and refined by secret processes, known only to the manufacturers and jealously guarded. The output of the mine is stated at 4,000 tons of nickel annually.

Aluminium.—The wonderful qualities of this metal are more or less well known, the principal of which are comparative lightness, great ductility, and its anti-corrosive nature. Hitherto, it has not been extensively used, owing to its high cost, but now aluminium brass, bronze, and ferro-alloys are sold at comparatively low prices, and it appears probable that there will shortly be a revolution in the manufacture of some of the materials used in marine engineering and shipbuilding.

Recently Mr. J. Farquharson, for 30 years with the British Admiralty, and its chief metal expert, has made two extended visits to the works of the Cowles Syndicate Company, near Stoke-upon-Trent, and there personally made many tests and trials of the Cowles standard alloys. In his report, he states: "For bearings and all work that can be cast in chill, the bronze alloys are, in my opinion, superior to any metal previously in use. As regards the brasses, composed of copper, spelter, and aluminium, they have properties which make them comparable with gun metal and other bronzes used as cast, rather than with the brasses proper, mainly composed of copper and spelter;" and in his opinion they are, as regards reliability, strength, and stiffness, greatly superior to all other alloys in use. The No. 2 aluminium brass is, he states, the best metal for screw propellers, stern-posts and stems of ships, at present known, and is remarkable for the qualities required in such work, having a tensile strength as cast, as high as 34 tons per

square inch, with an elastic limit of 26 tons, and yet capable of standing severe blows without breaking.

It is not, however, in combination with copper, that the greatest use of aluminium may be expected.

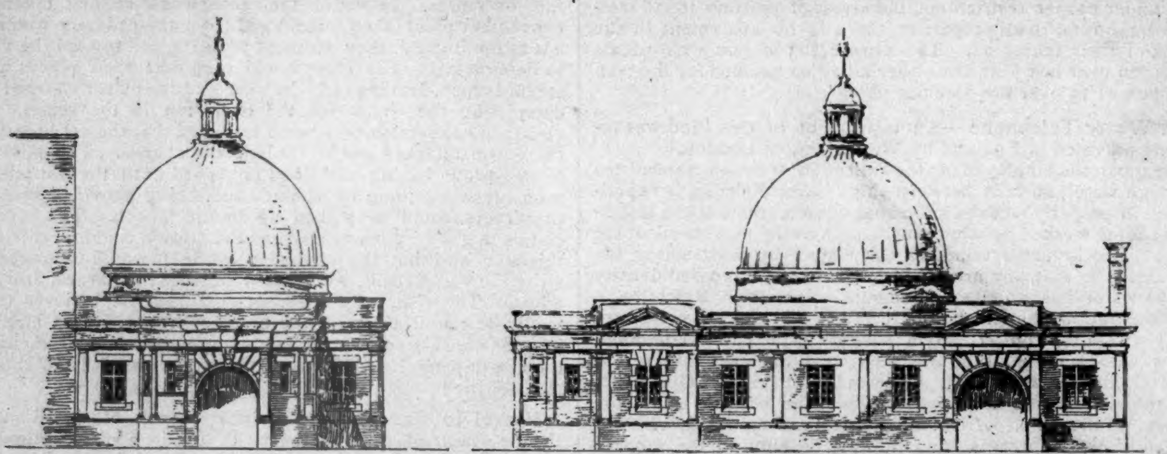
When a small percentage in the form of ferro-aluminium is added to cast-iron, or in the puddling furnace, most remarkable results are obtained. Recently, a considerable demand has arisen for ferro-aluminium for foundry use, as the addition of small percentages of aluminium up to 1 per cent. has been found to improve the quality of cast-iron, and to permit the production of faultless castings from iron hitherto regarded as altogether unfit for foundry use. Similarly, the addition of only 0.25 per cent. in the puddling furnace has led to most satisfactory results. Comparative tests of ordinary puddled bars of iron, and of bars rolled from the same quality of iron, but with the addition of 0.25 per cent. of aluminium, in the form of ferro-aluminium, show that whereas the ordinary iron had a tensile strain of about 18 tons per square inch, and an elongation of 10 per cent. in 8 in., bars having the above-mentioned small percentage of aluminium have a tensile strain of 31 tons per square inch, with 22 per cent. elongation in 8 in., and the bending tests showed equally good results.

It would thus appear that the alloys of aluminium will be found to be of increasingly great practical and commercial importance. The pure substance is still so very costly, about $3.75 per pound (the price has recently been reduced about one-half), that its sole use in shipbuilding, engineering, and boiler-making is out of the question; but the adoption of small percentages, securing great economical results in inferior metals, may be said to have been practically realized. The more general adoption of aluminium alloys for propellers, bearings of engines, etc., is also highly probable, seeing the increasing speeds at which marine and other engines are driven, necessitating more reliable materials than those hitherto in use. Similarly its alloy ferro-aluminium in iron and steel manufacture may be expected to exercise a useful function.—*The Nautical Magazine.*

A New Method of Tempering Steel—A paper on this subject was read before the London section of the Society of Chemical Industry by Mr. Watson Smith, Lecturer in Chemical Technology in University College, London. The new method in question is the invention of Captain G. Feodossieff, of the Imperial Russian Navy, St. Petersburg, Inspector of all metals used in naval construction in the Imperial arsenal. In this process, protected by letters-patent in England, glycerine is the substance or medium proposed, and it is employed for the hardening, tempering, or annealing of steel, cast steel or cast iron. The Lecturer referred to the British Association address of 1889, by Professor W. C. Roberts Austen, Chemist to the Mint, where he had referred to the confusion at present existing in the use of the words "hardening," "tempering" and "annealing" as applied to steel, the outcome being the following clear definitions: "Hardening is the result of rapidly cooling a strongly heated mass of steel; tempering, that of reheating the hardened steel to a temperature far short of that to which it was raised before hardening—this heating being followed or not being followed by rapid cooling; while annealing consists in heating the mass to a temperature higher than that used for tempering, and allowing it to cool slowly." Captain Feodossieff proposes to vary the specific gravity of the glycerine to be used from 1.08 to 1.26 at 15° C. by the addition of water, according to the composition of the steel and the effect desired. The quantity of glycerine is to be from one to six times greater in weight than that of the pieces to be plunged into it, and, in accordance with the hardening of the metal, its temperature is to be varied from 15° to 200° C., a high temperature being employed for the tempering of the harder steels, while a lower temperature is used for tempering the milder steels. Additions of various salts to the glycerine baths are recommended to increase their quenching power. Thus, for a hard temper, manganous sulphate may be added in quantity varying from 1 up to 34 per cent. of the liquid, or from ½ to 4 per cent. of potassium sulphate; for a softer temper, 1 to 10 per cent. of manganese chloride, and 1 to 4 per cent. of potassium chloride may be added.

Articulated Compound Locomotives.—The Swiss Central Railroad has ordered several four-cylinder Mallet articulated compound locomotives. The new Swiss tank engines will be carried on eight wheels, coupled in two groups, driven each by a separate pair of high and low-pressure cylinders, while the front or low-pressure group is made to swivel as a bogie. The weight of an engine, fully equipped, will be 52 tons, or 13 tons per axle.

A London City Railroad Station.—The accompanying sketch shows one of the six stations now being erected along the route from King William Street to Stockwell by the city of London & Southwark Subway Company. All the edifices vary in plan and arrangement, but the exteriors possess some common features. The principal one is the great circular shaft



down which the passengers will be taken to the railway below. The domes will not only be important landmarks for the public, but will also serve to take the wheels and gear with which the elevator will be worked.

It was proposed to use copper for the external covering, in order to secure not only increased durability but also the poetic charm of coloring incidental to the use of this material. The expense was, however, found to be too great, and the domes are being excellently covered with Vielle Montagne zinc, without the use of solder.

The stations are being built of red brick and Bath stone. The entire works are being carried out by Messrs. J. Simpson & Son, under the superintendence of the architect, Mr. T. Phillips Figgis.—*London Railway Press.*

Six-Cylinder Triple-Expansion Engine.—The Fall River Iron Works mill is driven by a six-cylinder triple-expansion Corliss engine, or perhaps it may be better described as two complete tandem triple-expansion engines attached to opposite ends of the same shaft. It is rated at 1,300 H. P. when running at the rate of 65 revolutions per minute, and with 150 lbs. initial pressure. The high pressure cylinders are 16½ in. in diameter, the intermediate 28 in., and the low pressure 42 in., the stroke being 5 ft. The fly-wheel is 28 ft. in diameter, 114 in. on the face and carries four belts, two of which are 32 in. in width, one 26 in. and one 16 in. The pulley weighed, when finished, 97,728 lbs. The cylinders are steam jacketed and cased in sheet metal instead of the usual black walnut lagging. The wrist plate is superseded by the more modern arrangement now used by the Corliss Company, securing a more rapid movement to the valve. Each cylinder is provided with the Corliss Company's new release valve, allowing for the escape of entrained water. This consists of a long flat steel spring, the ends of which press upon valves located in the back bonnets of the exhaust ports. An excessive pressure, such as would be generated by the confinement of water in the cylinder, lifts these valves against the action of the springs and allows the water to escape. The engines have been in continuous operation since October 15, 1889, and develop 1,400 H. P.—*Providence Journal.*